DEQ
Montana Department
of Environmental Quality

MAILED
9/21/20
mfm

September 21, 2020

Glen Rafish - Manager
**Butte-Silver Bow Landfill**
126 West Granite Street
Butte, MT 59701-9216

**RE: Closed Butte-Silver Bow County Landfill – March 2020 Semiannual Groundwater Monitoring Report**

Dear Mr. Rafish:

We have reviewed Pioneers' report and it meets the requirements of the Administrative Rules of Montana Title 17, chapter 50, subchapter 13.

The exceedances (EPA's Maximum Contaminant Levels and Montana Human Health Standards) detected in groundwater monitoring wells are consistent with results from previous years.

The facility remains in corrective action with semiannual monitoring. If you have any questions, please contact me.

Sincerely,

Mike Eder
Hydrogeologist
Solid Waste Program
Phone: 406-444-1434
mike.eder@mt.gov

cc: Joseph S. McElroy, Principal Engineer, Pioneer Technical Services, PO Box 3445, Butte, MT 59702
Mark Neary, Director of Public Works, Butte-Silver Bow, 126 W. Granite St, Butte, MT 59701-9216

file: Silver Bow County (closed files)/License #20/groundwater corrective measures

DEQ
Montana Department
of Environmental Quality

MAILED
AS 12/30/19

December 31, 2019

Glen Rafish
Butte-Silver Bow Landfill Manager
126 West Granite Street
Butte, MT 59701-9216

**RE: Closed Butte-Silver Bow County Landfill – April and September 2019 Semiannual Groundwater Monitoring Reports**

Dear Mr. Rafish:

We have reviewed Pioneers' reports and they meet the requirements of the Administrative Rules of Montana Title 17, chapter 50, subchapter 13.

The exceedances (EPA's Maximum Contaminant Levels and Montana Human Health Standards) detected in groundwater monitoring wells are consistent with results from previous years.

The facility remains in corrective action with semiannual monitoring. If you have any questions please contact me.

Sincerely,

Mike Eder
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file: Silver Bow County (closed files)/License #20/groundwater corrective measures

PIONEER

COUNTY: Silver Bow
FACILITY & #: 20 Closed
CLOSURE LANDFARM
FINAN ASSUR LINER
[✓ GW CORR MEAS] METHANE
GW MONITORING RUN OFF/ON
INSPECTIONS O & M
OTHER:

ECEIVED
JUN 24 2022
Dept. of Enviro. Quality
Waste & Underground
ank Management Bureau

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[illegible]nv
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[illegible]
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RE: [illegible]ur[illegible]r Bow Closed Landfill
[illegible]n[illegible]

[illegible]

[illegible], Pioneer Technical Services, Inc. (Pioneer) conducted the semi-[illegible]ring event for the Butte-Silver Bow (BSB) Closed Landfill and Clark [illegible]ater monitoring event consisted of collecting depth-to-groundwater [illegible]eters, and water quality samples from three monitoring wells at the [illegible] MBMG-2, BSB-A1, and BSB-A6R) and from two monitoring wells [illegible]vells CLK-1 and CLK-2) (Figure 1). Pioneer was not able to collect [illegible] quality samples from well BSB-A5 because there was not enough [illegible]ollowed the procedures outlined in the *Old Landfill Facility* [illegible]*d Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the [illegible]ta. The groundwater monitoring data and water quality results have [illegible]indwater potentiometric map, calculate groundwater velocities, [illegible]y trends, and conduct statistical analyses of the groundwater [illegible] this groundwater monitoring report, the following support documents have been included for your review:

- A figure showing the location of the groundwater monitoring wells (Figure 1).
- The Groundwater Potentiometric Surface Map for March 2022 (Figure 2).
- A document comparing the March 2022 results to previous results, maximum baseline and background concentrations, and groundwater protection standards (Attachment 1).
- A table comparing the March 2022 analytical data to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards (Table 1).
- A table showing the groundwater monitoring data and a non-parametric comparison of the monitoring wells (Table 2) (included electronically with this letter).
- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- A copy of field notes and sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota, and Duluth, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A6R, CLK-1, and CLK-2.

PIONEER
TECHNICAL SERVICES, INC.

RECEIVED
JUN 2 4 2022
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

June 20, 2022

Mr. Mike Eder
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear Mr. Eder:

On March 22 and 23, 2022, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring event for the Butte-Silver Bow (BSB) Closed Landfill and Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from three monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer was not able to collect field parameters and water quality samples from well BSB-A5 because there was not enough water in the well. Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

- A figure showing the location of the groundwater monitoring wells (Figure 1).
- The Groundwater Potentiometric Surface Map for March 2022 (Figure 2).
- A document comparing the March 2022 results to previous results, maximum baseline and background concentrations, and groundwater protection standards (Attachment 1).
- A table comparing the March 2022 analytical data to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards (Table 1).
- A table showing the groundwater monitoring data and a non-parametric comparison of the monitoring wells (Table 2) (included electronically with this letter).
- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- A copy of field notes and sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota, and Duluth, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A6R, CLK-1, and CLK-2.

For the semi-annual groundwater monitoring event at the BSB Closed Landfill and Clark Tailings site, Pioneer typically collects one field blank sample. To improve database management, starting March 2022 Pioneer now collects two field blank samples, one at each site.

The following sections provide a summary of the groundwater velocity calculations and statistical analysis conducted by Pioneer for the BSB Closed Landfill and Clark Tailings site.

**Groundwater Velocity Calculations**

Using the depth-to-groundwater measurements collected during the March 2022 monitoring event, a groundwater potentiometric surface map was developed (Figure 2). Based on Figure 2, groundwater flows in a northern direction at a hydraulic gradient ranging from 0.0348 feet per foot (ft/ft) to 0.0392 ft/ft. This is consistent with the past groundwater flow direction and range of hydraulic gradients. Using the hydraulic gradients, two groundwater velocities were calculated using both Darcy's Law and the equation for the seepage velocity. The average groundwater velocity for the March 2022 sampling event was 0.3489 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the average groundwater velocity was acquired from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

**Water Quality Results**

The March 2022 sampling event at the BSB Closed Landfill and Clark Tailings site was conducted according to the modified assessment-monitoring program. The water quality results from each well were compared to EPA's Maximum Contaminant Levels and the Montana Human Health Standards using Table 1.

The March 2022 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well [MBMG-2]) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A6R, CLK-1, and CLK-2 have also been attached. Please note that Pioneer did not collect water quality samples from well BSB-A5.

The results from the March 2022 sampling event indicate that the groundwater quality from wells BSB-A6R (central well), CLK-1 (Clark Tailings east well), and CLK-2 (Clark Tailings north well) exceeded EPA's Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years. Please refer to Attachment 1 for a summary of the March 2022 results.

**Statistical Analysis**

Pioneer has calculated a confidence level of 98.3% per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

If you have any questions or concerns, please contact me at (406) 497-8056.

Sincerely,

Patricia Olson

Patty Olson
Senior Engineer

Encl.

cc: Mark Neary, BSB Public Works Director
Julia Crain, BSB Reclamation & Environmental Services Assistant Director (email)
Chet Erwin, BSB Landfill Manager
Joseph S. McElroy, Pioneer Project Manager (email)
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Josh Bryson, Atlantic Richfield (email)
Loren Burmeister, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com
DEQSWProgram@mt.gov

**Figure 1 – Butte-Silver Bow Closed Landfill/Clark Tailings Groundwater Monitoring Wells**

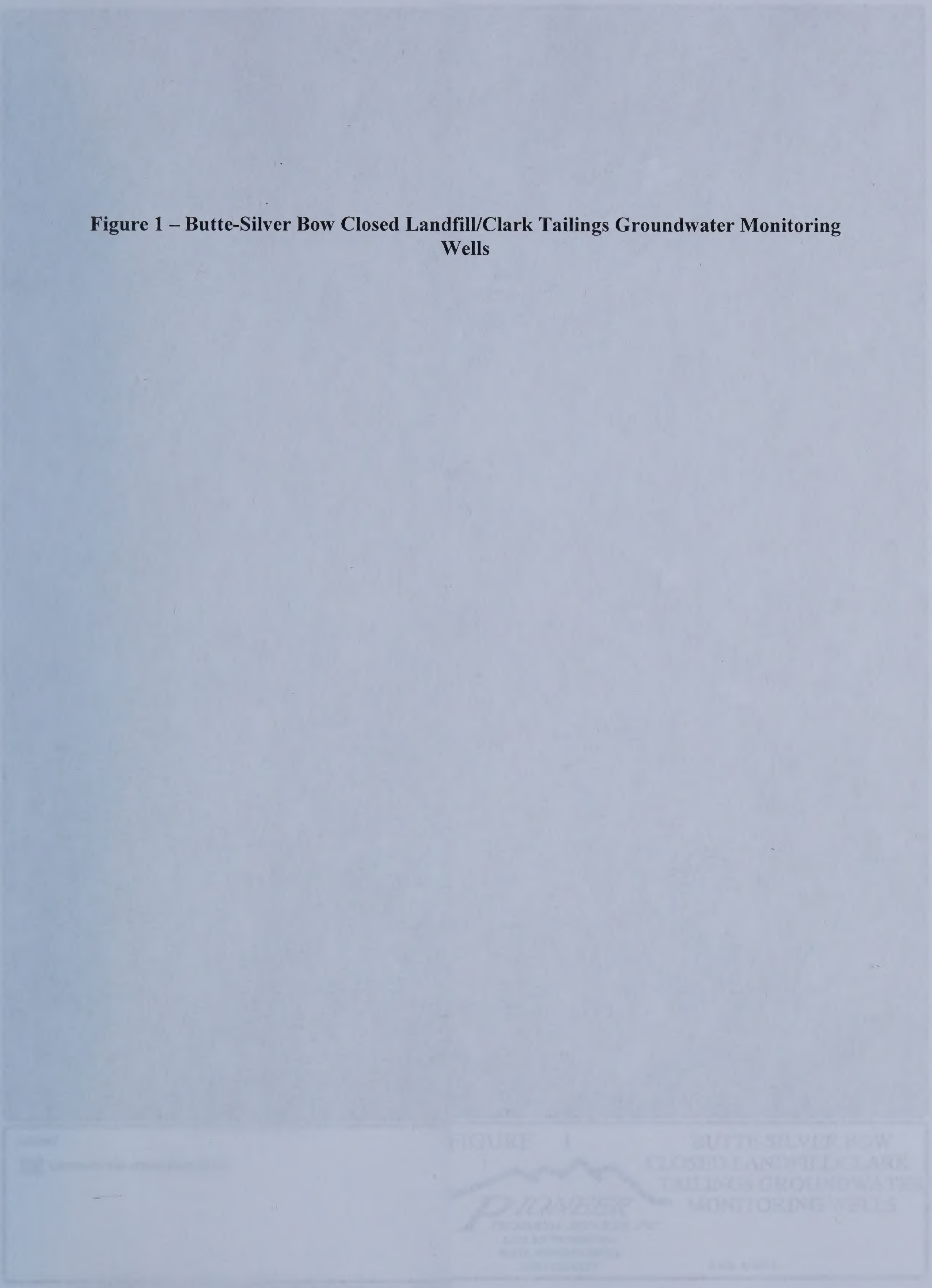
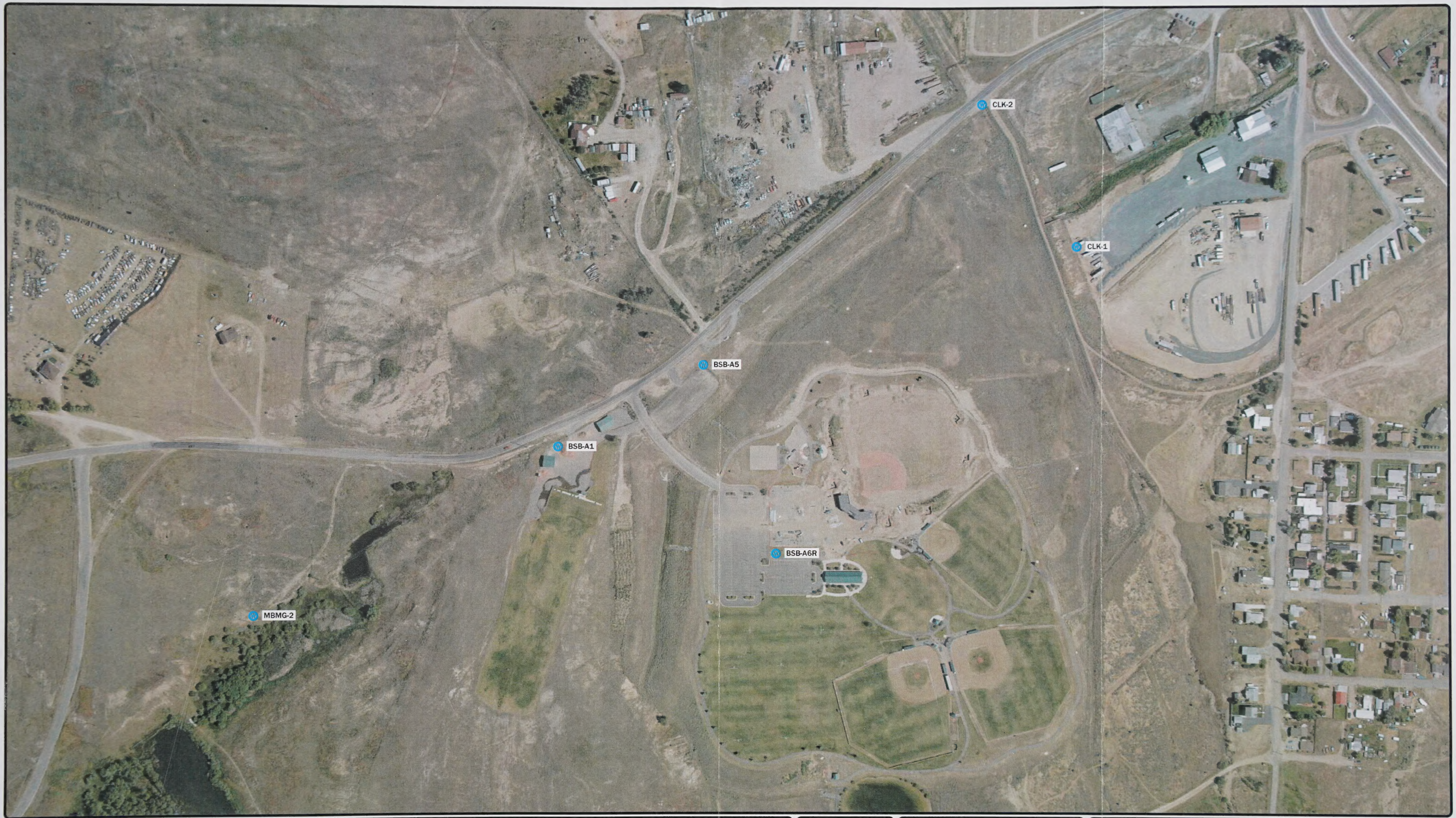


FIGURE 1
BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS
PIONEER



LEGEND

● GROUNDWATER MONITORING WELLS

N

| DISPLAYED AS: | |
|---|---|
| COORD SYS/ZONE: | MSP83 |
| DATUM: | NAVD88 |
| UNITS: | IF |
| SOURCE: | PIONEER/AES |

SCALE IN FEET
0 100 200

FIGURE 1

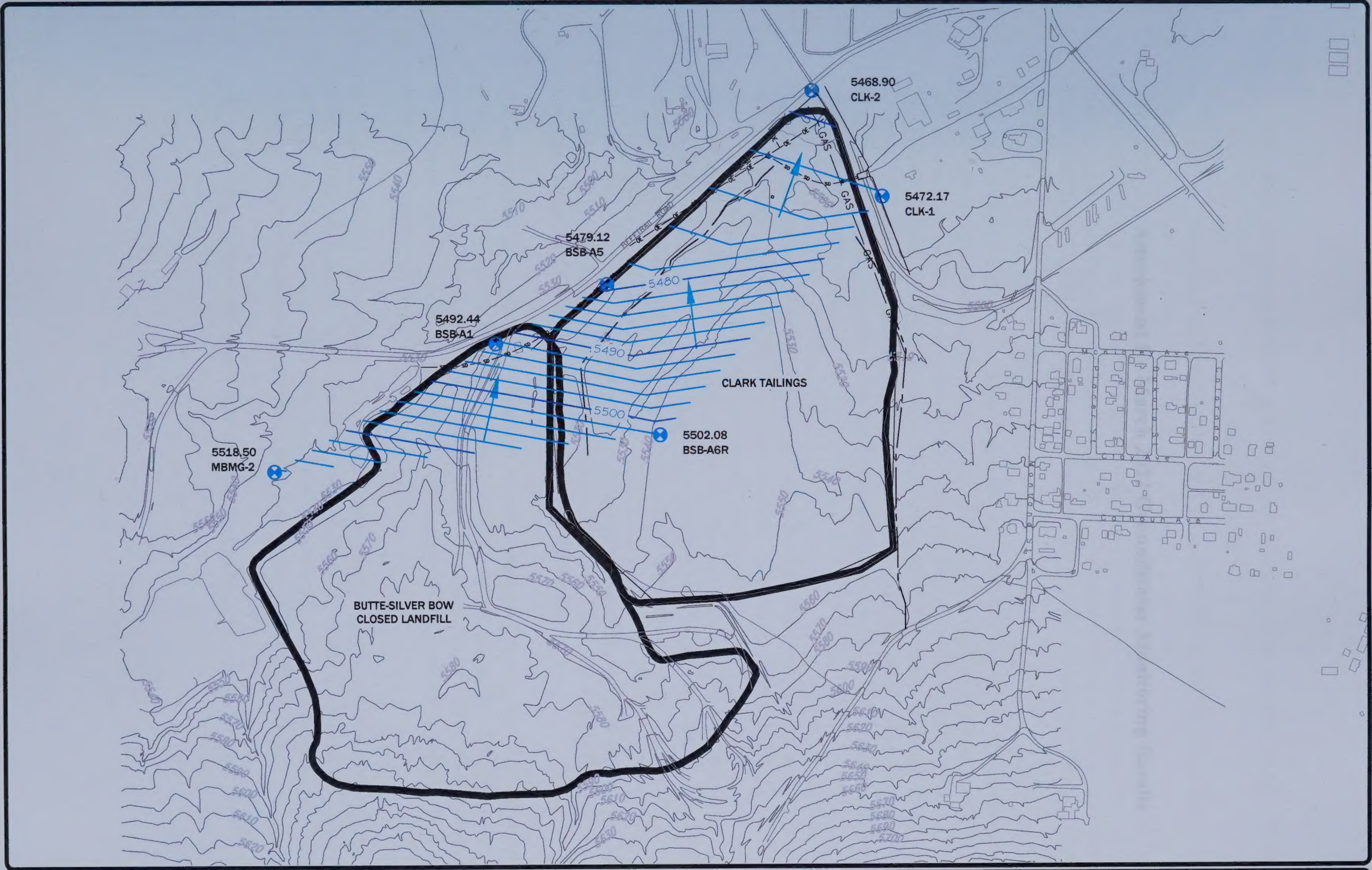
# BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-001-18.DWG

# Figure 2 – BSB Closed Landfill and Clark Tailings Groundwater Potentiometric Surface Map March 2022


5468.90
CLK-2
5472.17
CLK-1
5479.12
BSB-A5
5492.44
BSB-A1
5502.08
BSB-A6R
5518.50
MBMG-2
5480
5490
5500
CLARK TAILINGS
BUTTE-SILVER BOW
CLOSED LANDFILL
GAS
McKINLEY AVE
CLAY AVE
CALHOUN AVE

## LEGEND

CLK-1 ● GROUNDWATER MONITORING WELL
CONTOUR, INTERVAL = 10'
GROUNDWATER CONTOURS

N

| DISPLAYED AS: | |
|---|---|
| COORD SYS/ZONE: | NA |
| DATUM: | NA |
| UNITS: | FEET |
| SOURCE: | PIONEER |

SCALE IN FEET
0 300 600

FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

BSB CLOSED LANDFILL
AND CLARK TAILINGS
GROUNDWATER
POTENTIOMETRIC
SURFACE MAP
MARCH 2022

DATE: 5/2022

4/28/2022 8:41:56 AM Z:\SHARED\ACTIVE PROJECTS\CITYOFBUTTE\LANDFILLCLOSED\GWSAMPLING\CADD\FIGURES\LNDFL-GW-MARCH-PLN-001-22.DWG

# Attachment 1 – March 2022 Groundwater Monitoring Results

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS

## ATTACHMENT 1

## MARCH 2022 GROUNDWATER MONITORING RESULTS

The March 2022 groundwater sampling event at the Butte-Silver Bow (BSB) Closed Landfill and Clark Tailings site was conducted according to the modified assessment-monitoring program. The water quality results from each well were compared to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards using Table 1.

The March 2022 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well [MBMG-2]) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A6R, CLK-1, and CLK-2 have also been attached. For the March 2022 sampling event, Pioneer was not able to collect field parameters and water quality samples from well BSB-A5 because there was not enough water in the well.

For the trend graphs for wells BSB-A1 and BSB-A6R, please note that the increased results of volatile organic compounds (VOCs) observed in the September 2021 sampling event were due to the samples being analyzed by the Pace Analytical Services, LLC laboratory in Indianapolis, which has higher VOC reporting limits than the Minneapolis laboratory that typically analyzes the samples. The Indianapolis laboratory analyzed the September 2021 VOC samples to meet sample hold times as the Minneapolis laboratory had instrument issues.

As outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan* (SAP) (Pioneer, 2015), samples collected from wells MBMG-2, BSB-A1, and BSB-A6-R were analyzed for sulfide during the March 2022 sampling event.

As requested by the Montana Department of Environmental Quality (DEQ) in May 2013, wells MBMG-2, CLK-1, and CLK-2 will be analyzed for mercury biennially. The 2020 sampling events included mercury analysis for these wells. Therefore, the March 2022 samples collected from wells MBMG-2, CLK-1, and CLK-2 were analyzed for mercury to comply with the biennial schedule requested by DEQ.

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in wells MBMG-2, BSB-A1, BSB-A6R, CLK-1, and CLK-2 during the March 2022 sampling event. In addition, samples for metals analyses were not collected from wells BSB-A1 and BSB-A6R during the March 2022 event.

The following sections provide a summary of the results and findings for each well.

**Well MBMG-2 (Upgradient):**
**Sample ID: BSB-GW-01**

The following metals were detected, but at concentrations below the maximum background: antimony (Sb) (0.000097 J milligrams per Liter [mg/L]), arsenic (As) (0.0012 mg/L), barium (Ba) (0.13 mg/L), beryllium (Be) (0.000048 J mg/L), chromium (Cr) (0.00043 J mg/L), cobalt (Co) (0.0001 J mg/L), copper (Cu) (0.00092 J mg/L), iron (Fe) (0.032 J mg/L), nickel (Ni) (0.00034 J mg/L), selenium (Se) (0.0012 mg/L), and vanadium (V) (0.0066 mg/L). Cadmium (Cd), lead (Pb), zinc (Zn), and mercury (Hg) were not detected.

No VOCs were detected in well MBMG-2 during the March 2022 sampling event.

Nitrate (4.90 mg/L), sulfate (151 mg/L), chloride (65.70 mg/L), and specific conductance (740 micromhos per centimeter [µmhos/cm]) were detected, but at concentrations below the maximum background. Sulfide, chemical oxygen demand, and cyanide were not detected during the March 2022 sampling event.

Analytical results from well MBMG-2 did not exceed any of EPA's Maximum Contaminant Levels or the Montana Human Health Standards during the March 2022 sampling event.

**Well BSB-A1 (North Well):**
**Sample ID: BSB-GW-02**

Three VOCs (cis-1,2-Dichloroethene [0.18 J µg/L], trichloroethene [0.27 J µg/L], and vinyl chloride [0.083 J µg/L]) were detected, but at concentrations below the maximum baseline and background. Nitrate (0.16 mg/L), sulfate (68.60 mg/L), chloride (18.30 mg/L), and specific conductance (413 µmhos/cm) were detected, but at concentrations below the maximum baseline and background. Sulfide was detected at 0.055 J mg/L. Cyanide and chemical oxygen demand were not detected.

The March 2022 results from well BSB-A1 were compared to EPA's Maximum Contaminant Levels and the Montana Human Health Standards and no exceedances were observed.

The attached trend graph for well BSB-A1 shows that the results from March 2022 are consistent with the results from previous sampling events.

**Well BSB-A6R (Central Well):**
**Sample ID: BSB-GW-04**

Monitoring well BSB-A6R is the replacement well for BSB-A6, which was removed during construction of the Timber Butte Youth Park.

The following VOCs were detected in well BSB-A6R during the March 2022 sampling event:

- Benzene (0.44 J µg/L).
- 1,4-Dichlorobenzene (0.58 J µg/L).

- Dichlorodifluoromethane (0.41 J µg/L).
- 1,1-Dichloroethane (0.44 J µg/L).
- cis-1,2-Dichloroethene (1.30 µg/L) exceeds the maximum background concentration.
- 1,2-Dichloropropane (0.15 J µg/L).
- Vinyl chloride (0.94 J µg/L) exceeds the Montana Human Health Standard (0.2 µg/L).

The VOC results are consistent with the previous results, as the attached trend graphs for well BSB-A6R show.

Sulfate (4,350 mg/L), specific conductance (5,240 µmhos/cm), and chemical oxygen demand (1,240 mg/L) were detected above the maximum background concentrations. Chloride (63.70 mg/L) and cyanide (0.0125 J mg/L) were detected at concentrations below the maximum baseline and background. Sulfide and nitrate were not detected. The attached trend graphs for well BSB-A6R show that the levels of chloride (63.70 mg/L) increased, and sulfate (4,350 mg/L) decreased when compared to previous sampling events (i.e., March 2021 and September 2021).

Results from the March 2022 sampling event also show that the levels of sulfate (4,350 mg/L) exceeded EPA's Maximum Contaminant Level (250 mg/L).

**Well CLK-1 (Clark Tailings East Well):**
**Sample ID: BSB-GW-05-20220322**

Metals detected above the maximum background concentrations, but below the maximum baseline concentrations include the following: As (0.10 mg/L), Cd (0.0087 mg/L), Co (0.042 mg/L), Fe (15.00 mg/L), Ni (0.039 mg/L), and Zn (38.40 mg/L).

Antimony (0.0001 J mg/L), Ba (0.025 mg/L), Be (0.00023 mg/L), Cu (0.0016 mg/L), Hg (0.000008 J mg/L), Se (0.00022 J mg/L) and V (0.00036 J mg/L) were detected, but at concentrations below the maximum baseline and background. The results for Cr and Pb were non-detect.

Arsenic (0.10 mg/L), Cd (0.0087 mg/L), Fe (15.00 mg/L), and Zn (38.40 mg/L) also exceeded EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Levels of sulfate (917 mg/L) and specific conductance (1,720 µmhos/cm) exceeded the maximum background concentrations. Chloride (29.8 mg/L) was detected, but at levels below the maximum baseline and background. Levels of sulfate (917 mg/L) were also higher than EPA's Maximum Contaminant Level (250 mg/L).

The attached trend graph for well CLK-1 shows that the results for Sb, As, Cd, Fe, and Zn generally decreased when compared to previous sampling events.

**Well CLK-2 (Clark Tailings North Well):**
**Sample ID: BSB-GW-06-20220322**

Antimony (0.00017 J mg/L), As (0.0012 mg/L), Ba (0.015 mg/L), Cd (0.000064 J mg/L), Cr (0.00058 J mg/L), Co (0.0003 J mg/L), Cu (0.0026 mg/L), Hg (0.000052 mg/L), Ni (0.0019 mg/L), Se (0.00014 J mg/L), V (0.0016 mg/L), and Zn (0.048 mg/L) were detected, but at concentrations below the maximum baseline and background. The results for Be, Fe, and Pb were non-detect. The attached trend graph for well CLK-2 shows that the levels of Zn (0.048 mg/L) are consistent when compared to previous sampling events.

Levels of sulfate (635 mg/L) continue to increase when compared to previous sampling events. Sulfate (635 mg/L) and specific conductance (1,470 µmhos/cm) exceeded the maximum background concentrations. Chloride (72.40 mg/L) was detected, but at concentrations below the maximum baseline and background.

Sulfate concentrations (635 mg/L) were also higher than EPA's Maximum Contaminant Level (250 mg/L).

## Summary:

The March 2022 groundwater sampling event at the BSB Closed Landfill and Clark Tailings site was conducted according to the modified assessment-monitoring program. Using the attached Table 1, Table 2, and trend graphs, the March 2022 results were compared to previous results, maximum baseline and background concentrations, and EPA's Maximum Contaminant Levels and the Montana Human Health Standards. Water quality samples were not collected from well BSB-A5 (northeast well) because there was not enough water in the well.

Sample analyses from well MBMG-2 (upgradient well) showed levels of metals, nitrate, sulfate, chloride, and specific conductance, but at concentrations below the maximum background. Volatile organic compounds, sulfide, chemical oxygen demand, and cyanide were not detected, and all results were below EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds, nitrate, sulfate, chloride, and specific conductance were detected in well BSB-A1 (north well), but at concentrations below the maximum baseline and background. Sulfide was also detected in well BSB-A1 (north well). Cyanide and chemical oxygen demand were not detected. All results from this well were below EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Seven VOCs were detected in well BSB-A6R (central well). Of the VOCs detected, cis-1,2-Dichloroethene exceeded the maximum background concentration and vinyl chloride exceeded the Montana Human Health Standard.

Monitoring well BSB-A6R (central well) results for sulfate, specific conductance, and chemical oxygen demand exceeded the maximum background concentrations. Sulfate was also higher than

EPA's Maximum Contaminant Level. Chloride and cyanide were detected at concentrations below the maximum baseline and background. Sulfide and nitrate were not detected.

Monitoring well CLK-1 (Clark Tailings east well) had levels of metals (i.e., As, Cd, Co, Fe, Ni, and Zn) detected above the maximum background concentrations, but below the maximum baseline concentrations. Arsenic, Cd, Fe, and Zn were also higher than EPA's Maximum Contaminant Levels and the Montana Human Health Standards. Levels of sulfate and specific conductance were higher than the maximum background concentrations, with sulfate exceeding EPA's Maximum Contaminant Level. Chloride was detected, but at levels below the maximum baseline and background.

Metals (i.e., Sb, As, Ba, Cd, Cr, Co, Cu, Hg, Ni, Se, V, and Zn) were detected in well CLK-2 (Clark Tailings north well) at concentrations below the maximum baseline and background. Sulfate and specific conductance exceeded the maximum background concentrations, with sulfate also exceeding EPA's Maximum Contaminant Level. Chloride was detected, but at concentrations below the maximum baseline and background.

The results from the March 2022 sampling event indicate that the groundwater quality from wells BSB-A6R (central well), CLK-1 (Clark Tailings east well), and CLK-2 (Clark Tailings north well) exceeded EPA's Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years.

# Table 1: Analytical Data and Groundwater Protection Standards

3/1/2022

| SAMPLE NUMBER | BSB-GW-01 | BSB-GW-02 | SB-GW-09 | BSB-GW-10 | GW PROTECTION STANDARDS | |
|---|---|---|---|---|---|---|
| WELL | MBMG-2 | BSB-A1 | ield Blank | Field Blank | EPA<br>MCL* | MONTANA<br>HHS |
| ANALYTE (units): | | | | | | |
| **DISSOLVED METALS (mg/L)** | | | | | | |
| Antimony | (Pace 0.000097 J)< 0.0005 | SA | 95 J)< 0.0005 | Pace 0.000099 J)< 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0012 | SA | < 0.0005 | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.13 | SA | < 0.0003 | < 0.0003 | 2 | 2 |
| Beryllium | (Pace 0.000048 J)< 0.0002 | SA | < 0.0002 | Pace 0.000035 J)< 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | SA | < 0.00008 | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00043 J)< 0.002 | SA | < 0.002 | < 0.002 | 0.1 | 0.1 |
| Cobalt | (Pace 0.0001 J)< 0.0005 | SA | < 0.0005 | < 0.0005 | - - - | - - - |
| Copper | (Pace 0.00092 J)< 0.001 | SA | < 0.001 | 0.0014 | 1.3 (a) | 1.3 |
| Iron | (Pace 0.032 J)< 0.05 | SA | < 0.05 | < 0.05 | 0.3(s) | 0.3 |
| Lead | < 0.0005 | SA | < 0.0005 | (Pace 0.00015 J)< 0.0005 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | SA | < 0.00001 | < 0.00001 | 0.002 | 0.002 |
| Nickel | (Pace 0.00034 J)< 0.0005 | SA | < 0.0005 | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.0012 | SA | < 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | SA | NR | NR | 0.1 | 0.1 |
| Thallium | NR | SA | NR | NR | 0.002 | 0.002 |
| Tin | NR | SA | NR | NR | | |
| Vanadium | 0.0066 | SA | < 0.001 | < 0.001 | - - - | - - - |
| Zinc | < 0.005 | SA | < 0.005 | < 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | |
| Chloride | 65.7 | 18.3 | < 1.2 | < 1.2 | 250 | - - - |
| Chemical Oxygen Demand | < 50 | < 50 | NR | SA | - - - | - - - |
| Specific Conductance (umhos/cm) | 740 | 413 | < 5 | < 5 | - - - | - - - |
| Cyanide | < 0.02 | < 0.02 | NR | SA | - - - | 0.2 |
| Nitrate\Nitrite - N | 4.9 | 0.16 | NR | SA | 10 | 10 |
| pH | 7.8 | 7.3 | 5.8 | 5.7 | | |
| Sulfate | 151 | 68.6 | < 1.2 | < 1.2 | 250 | - - - |
| Sulfide | < 0.1 | (Pace 0.055 J)< 0.1 | NR | SA | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | |
| Acetone | < 10 | < 10 | SA | < 10 | - - - | - - - |
| Benzene | < 1 | < 1 | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | SA | < 1 | - - - | - - - |
| Chloroethane | < 1 | < 1 | SA | < 1 | - - - | - - - |
| Chloroform | < 1 | < 1 | SA | 7.2 | - - - | 70 |
| Chloromethane | < 1 | < 1 | SA | < 1 | - - - | - - - |
| 1,4-Dichlorobenzene | < 1 | < 1 | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | SA | < 1 | - - - | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | SA | < 1 | - - - | - - - |
| 1,2-Dichloroethane | < 1 | < 1 | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | (Pace 0.18 J)< 1 | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | SA | < 1 | | |
| 1,2-Dichloropropane | < 1 | < 1 | SA | < 1 | 5 | 5 |
| 4-Isopropyltoluene | NR | NR | NR | NR | - - - | - - - |
| Methylene Chloride | < 1 | < 1 | SA | < 1 | 5 | 30 |
| Naphthalene | NR | NR | NR | NR | - - - | 100 |
| Tetrachloroethene | < 1 | < 1 | SA | < 1 | 5 | 5 |
| Trichloroethene | < 1 | (Pace 0.27 J)< 1 | SA | < 1 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | NR | NR | NR | - - - | - - - |
| Vinyl Chloride | < 1 | (Pace 0.083 J)< 1 | SA | < 1 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | NR | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | |
| Picloram | SA | SA | SA | NR | | |
| Dicamba | SA | SA | SA | NR | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | NR | | |
| 2,4-D | SA | SA | SA | NR | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | NR | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | NR | | |

**KEY:**

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

mg/L = milligr
µg/L = microg
EPA = U.S. E
MCL = Maxim
HHS = Monta

**NOTES:**

1. Water quality samples from well BSB-A5 were not collected because there was not enough water in the well.

3/1/2022

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 1: ANALYTICAL DATA AND GROUNDWATER PROTECTION STANDARDS
## DATES SAMPLED: March 22 and 23, 2022

| SAMPLE NUMBER | BSB-GW-01 | BSB-GW-02 | BSB-GW-03 | BSB-GW-04 | BSB-GW-05 | BSB-GW-06 | BSB-GW-07 | BSB-GW-08 | BSB-GW-09 | BSB-GW-10 | GW PROTECTION STANDARDS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WELL | MBMG-2 | BSB-A1 | BSB-A5 | BSB-A6R | CLK-1 | CLK-2 | BSB-A6R DUP | CLK-1 DUP | Field Blank | Field Blank | EPA | MONTANA |
| ANALYTE (units): | | | | | | | | | | | MCL* | HHS |
| **DISSOLVED METALS (mg/L)** | | | | | | | | | | | | |
| Antimony | (Pace 0.000097 J)< 0.0005 | SA | SA | SA | (Pace 0.0001 J)< 0.0005 | (Pace 0.00017 J)< 0.0005 | SA | (Pace 0.00011 J)< 0.0005 | (Pace 0.000095 J)< 0.0005 | Pace 0.000099 J)< 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0012 | SA | SA | SA | **0.1** | 0.0012 | SA | **0.098** | < 0.0005 | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.13 | SA | SA | SA | 0.025 | 0.015 | SA | 0.026 | < 0.0003 | < 0.0003 | 2 | 2 |
| Beryllium | (Pace 0.000048 J)< 0.0002 | SA | SA | SA | 0.00023 | < 0.0002 | SA | 0.00022 | < 0.0002 | Pace 0.000035 J)< 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | SA | SA | SA | **0.0087** | (Pace 0.000064 J)< 0.00008 | SA | **0.0086** | < 0.00008 | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00043 J)< 0.002 | SA | SA | SA | < 0.002 | (Pace 0.00058 J)< 0.002 | SA | < 0.002 | < 0.002 | < 0.002 | 0.1 | 0.1 |
| Cobalt | (Pace 0.0001 J)< 0.0005 | SA | SA | SA | 0.042 | (Pace 0.0003 J)< 0.0005 | SA | 0.043 | < 0.0005 | < 0.0005 | - - - | - - - |
| Copper | (Pace 0.00092 J)< 0.001 | SA | SA | SA | 0.0016 | 0.0026 | SA | 0.0018 | < 0.001 | 0.0014 | 1.3 (a) | 1.3 |
| Iron | (Pace 0.032 J)< 0.05 | SA | SA | SA | **15** | < 0.05 | SA | **15.2** | < 0.05 | < 0.05 | 0.3(s) | 0.3 |
| Lead | < 0.0005 | SA | SA | SA | < 0.0005 | < 0.0005 | SA | < 0.0005 | < 0.0005 | (Pace 0.00015 J)< 0.0005 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | SA | SA | SA | (Pace 0.000008 J)< 0.00001 | 0.000052 | SA | (Pace 0.000007 J)< 0.00001 | < 0.00001 | < 0.00001 | 0.002 | 0.002 |
| Nickel | (Pace 0.00034 J)< 0.0005 | SA | SA | SA | 0.039 | 0.0019 | SA | 0.04 | < 0.0005 | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.0012 | SA | SA | SA | (Pace 0.00022 J)< 0.0005 | (Pace 0.00014 J)< 0.0005 | SA | (Pace 0.00016 J)< 0.0005 | < 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | SA | SA | SA | NR | NR | SA | NR | NR | NR | 0.1 | 0.1 |
| Thallium | NR | SA | SA | SA | NR | NR | SA | NR | NR | NR | 0.002 | 0.002 |
| Tin | NR | SA | SA | SA | NR | NR | SA | NR | NR | NR | | |
| Vanadium | 0.0066 | SA | SA | SA | (Pace 0.00036 J)< 0.001 | 0.0016 | SA | (Pace 0.00039 J)< 0.001 | < 0.001 | < 0.001 | - - - | - - - |
| Zinc | < 0.005 | SA | SA | SA | **38.4** | 0.048 | SA | **42.1** | < 0.005 | < 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | | | | | | | |
| Chloride | 65.7 | 18.3 | SA | 63.7 | 29.8 | 72.4 | SA | 30 | < 1.2 | < 1.2 | 250 | - - - |
| Chemical Oxygen Demand | < 50 | < 50 | SA | 1,240 | NR | NR | SA | NR | NR | SA | - - - | - - - |
| Specific Conductance (umhos/cm) | 740 | 413 | SA | 5,240 | 1,720 | 1,470 | SA | 1,750 | < 5 | < 5 | - - - | - - - |
| Cyanide | < 0.02 | < 0.02 | SA | (Pace 0.0125 J)< 0.02 | NR | NR | SA | NR | NR | SA | - - - | 0.2 |
| Nitrate\Nitrite - N | 4.9 | 0.16 | SA | < 0.1 | NR | NR | SA | NR | NR | SA | 10 | 10 |
| pH | 7.8 | 7.3 | SA | 4.5 | 6.4 | 6.5 | SA | 6.4 | 5.8 | 5.7 | | |
| Sulfate | 151 | 68.6 | SA | **4,350** | **917** | **635** | SA | **929** | < 1.2 | < 1.2 | 250 | - - - |
| Sulfide | < 0.1 | (Pace 0.055 J)< 0.1 | SA | < 1 | NR | NR | SA | NR | NR | SA | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | | | | | | | |
| Acetone | < 10 | < 10 | SA | (Pace 4.6 J)< 10 | SA | SA | (Pace 5.4 J)< 10 | SA | SA | < 10 | - - - | - - - |
| Benzene | < 1 | < 1 | SA | (Pace 0.44 J)< 1 | SA | SA | (Pace 0.46 J)< 1 | SA | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | - - - | - - - |
| Chloroethane | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | - - - | - - - |
| Chloroform | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | 7.2 | - - - | 70 |
| Chloromethane | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | - - - | - - - |
| 1,4-Dichlorobenzene | < 1 | < 1 | SA | (Pace 0.58 J)< 1 | SA | SA | (Pace 0.62 J)< 1 | SA | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | SA | (Pace 0.41 J)< 1 | SA | SA | (Pace 0.45 J)< 1 | SA | SA | < 1 | - - - | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | SA | (Pace 0.44 J)< 1 | SA | SA | (Pace 0.45 J)< 1 | SA | SA | < 1 | - - - | - - - |
| 1,2-Dichloroethane | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | (Pace 0.18 J)< 1 | SA | 1.3 | SA | SA | 1.2 | SA | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | | |
| 1,2-Dichloropropane | < 1 | < 1 | SA | (Pace 0.15 J)< 1 | SA | SA | (Pace 0.19 J)< 1 | SA | SA | < 1 | 5 | 5 |
| 4-Isopropyltoluene | NR | NR | NR | NR | SA | SA | NR | SA | NR | NR | - - - | - - - |
| Methylene Chloride | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | 5 | 30 |
| Naphthalene | NR | NR | NR | NR | SA | SA | NR | SA | NR | NR | - - - | 100 |
| Tetrachloroethene | < 1 | < 1 | SA | < 1 | SA | SA | < 1 | SA | SA | < 1 | 5 | 5 |
| Trichloroethene | < 1 | (Pace 0.27 J)< 1 | SA | < 1 | SA | SA | (Pace 0.12 J)< 1 | SA | SA | < 1 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | NR | NR | NR | SA | SA | NR | SA | NR | NR | - - - | - - - |
| Vinyl Chloride | < 1 | (Pace 0.083 J)< 1 | SA | **(Pace 0.94 J)< 1** | SA | SA | **(Pace 0.91 J)< 1** | SA | SA | < 1 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | | | | | | | |
| Picloram | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |
| Dicamba | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |
| 2,4-D | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | NR | | |

**KEY:**

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

mg/L = milligram per Liter
µg/L = microgram per Liter
EPA = U.S. Environmental Protection Agency
MCL = Maximum Contaminant Levels
HHS = Montana Human Health Standards

**NOTES:**

1. Water quality samples from well BSB-A5 were not collected because there was not enough water in the well.

## Table 2: Groundwater Monitoring Data
(Included Electronically with this Letter)

# Table 3: Groundwater Field Chemistry Results and Purge Volumes

## BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 3: GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
### DATES SAMPLED: March 22 and 23, 2022

| Well ID | Sample # | Depth (ft) | Diameter (ft) | SWL (ft) | TOC Elevation (ft) | Groundwater Elevation (ft) | pH (su) | ORP (mV) | DO (mg/L) | SC (μS/cm) | T (Celsius) | Sample Time | $H_2O$ Volume Required (gal) | $H_2O$ Volume Purged (gal) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MBMG-2 | BSB-GW-01 | 23.20 | 0.17 | 11.38 | 5,529.88 | 5,518.50 | 6.58 | 436.90 | 4.20 | 784.00 | 6.80 | 9:51 | 5.91 | 19.00 | |
| BSB-A1 | BSB-GW-02 | 57.00 | 0.17 | 39.06 | 5,531.50 | 5,492.44 | 6.65 | 466.00 | 0.19 | 436.10 | 9.00 | 11:28 | 8.97 | 11.60 | |
| BSB-A5 | BSB-GW-03 | 45.60 | 0.17 | 45.50 | 5,524.62 | 5,479.12 | NA | NA | NA | NA | NA | NA | 0.05 | NA | Not enough water to purge or collect parameters and samples |
| BSB-A6R | BSB-GW-04 | 59.75 | 0.17 | 52.33 | 5,554.41 | 5,502.08 | 5.82 | 76.20 | 0.96 | 5,429.00 | 11.00 | 14:30 | 3.71 | 7.02 | |
| BSB-A6R | BSB-GW-07 | 59.75 | 0.17 | 52.33 | 5,554.41 | 5,502.08 | 5.82 | 76.20 | 0.96 | 5,429.00 | 11.00 | 14:20 | 3.71 | 7.02 | VOC Duplicate |
| CLK-1 | BSB-GW-05 | 19.00 | 0.17 | 6.56 | 5,478.73 | 5,472.17 | 6.36 | 101.80 | 0.32 | 1,760.00 | 8.20 | 11:38 | 6.22 | 7.00 | |
| CLK-2 | BSB-GW-06 | 46.90 | 0.17 | 42.27 | 5,511.17 | 5,468.90 | 6.32 | 272.10 | 1.04 | 1,512.00 | 10.30 | 10:23 | 2.32 | 3.36 | |
| CLK-1 | BSB-GW-08 | 19.00 | 0.17 | 6.56 | 5,478.73 | 5,472.17 | 6.36 | 101.80 | 0.32 | 1,760.00 | 8.20 | 11:45 | 6.22 | 7.00 | Raw and Dissolved Metals Duplicates |
| Blank | BSB-GW-09 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 9:10 | NA | NA | Field Blank |

**KEY:**

| | | | |
|---|---|---|---|
| ft | feet | SC | Specific Conductance |
| SWL | static water level | μS/cm | micro-Siemens per centimeter |
| TOC | top of casing | T | temperature |
| pH | Potential of Hydrogen | $H_2O$ | water |
| su | standard unit | gal | gallons |
| ORP | Oxidation Reduction Potential | NA | measurement not taken |
| mV | millivolts | | |
| DO | Dissolved Oxygen | | |
| mg/L | milligrams per Liter | | |

# Field Notes

12-15-21

collected CL2-GW-04-121521 @ 1328

1-250mL $HNO_3$ / Diss Metals / Filt.
1-250mL $H_2SO_4$ / $NO_2$, $NO_3$, COD
1-250mL NaOH / Cyanide.
1-1L Raw / pH, SC, $CL^-$, $SO_4^{-2}$
3-40mL HCL / VOC's 8260B

offsite Justin H @ 1400
Nate. F  No Decon.

samples stored in fridge at end of day.

12-16-21 Shipped samples (2 coolers) to Pace Analytical using FedEx PMO
Cooler #1 tracking: 5150 1598 4213
Cooler #2 tracking: 5150 1598 4224

12-17-21 Both coolers arrived at 08:32 PMO

12-17-21

3-22-22

GW Sampling Old Landfill

Justin H.
Nathan F. > Pioneer crew

Weather: 32 to 48F Cloudy

Calibration of YSI
pH 4 - 4.12
7 - 6.95  Slope: 95.57
10 - 10.13

S.C. 1413 mS/cm - 1410  K-cell: 4.56

ORP 400mv - 401.4  offset: 6.60

D.O.: Live - 81.9%. 7.55 mg/L B.P.: 628 mmHg

PPE Level D with nitrile gloves
Decon using C91 DI water
~~Pulled blank from C91~~ JH
used dedicated pump

CLK-2 Arrived at 09:30
DTW: 42.27'  TD: 46.90'
purge with dedicated 3 stage pump
Purge rate: 0.08 gpm

3/22/22

Start purging: 0941
Stop purging: 1023
Total gallons purged: 3.36 gal
Field parameters on FDS.

Collected BSB-GW-06 at 1023
1-250mL w/ $HNO_3$ filtered diss. metals + Hg
1-1L Raw pH / SC / $CL^-$ / $SO_4^{-2}$

off site at 1028

Decon pump at 1045 with 2 gallons of tap water + 2 gallons of D.I. water (bottle C91)

CLK-1 Arrived at 1055
DTW: 6.56' purge with: dedicated 3 stage
TD: 19.00' purge rate: 0.2 gpm
Start purging: 1103
Stop purging: 1138
Total gallons purged: 7.0 gal
Field parameters on FDS.

Collected BSB-GW-05 at 1138
1-250 mL w/ $HNO_3$ filtered diss. metals + Hg
1-1L Raw pH / SC / $CL^-$ / $SO_4^{-2}$

---

3/22/22

Collected BSB-GW-08 at 1145
1-250mL w/ $HNO_3$ Filtered diss. metals + Hg
1-1L Raw pH / SC / $CL^-$ / $SO_4^{-2}$
Sample BSB-GW-08 is the duplicate sample of well CLK-1.

Deconned pump at 1150 with 2 gallons of tap water + 2 gallons of D.I. water (bottle C91)

Samples placed into cooler/ice.
off site at 1200. (JH / NF-Pioneer).
Drove to LAO to dump purge water from CLK-1
Unload at office. Samples put into the sample refrigerator.

3/22/22
JH

Rite in the Rain

3-23-22

GW sampling old landfill

Justin.H ) Pioneer
Nate.F

weather 32-68 sunny

Calibration YSI

PH 10 - 10.13 slope 96.48
7 - 7.00
4 - 4.05

Cond 1413 - 1414
K-cell - 4.69

ORP 400 - 400.4 offset -11.39

D.O. 82.6% 7.60mg/L
627.29

PPE Level D used today with nitrile gloves.
Decon using C90 + C93 D.I. Bottles
Pulled blanks from C93 D.I. Bottle
Using S.S. 12v pump w/ dedicated tubing.
All samples stored in cooler w/ice after collection. PMO

MBMG-2 Arrived at 0919
DTW: 11.38' purged with: S.S. 12v pump w/
TD: 23.20' dedicated tubing.
purge rate: 1 gpm

3-23-22

Start purging: 0932
Stop purging: 0951
Total gallons purged: 19 gal
Field parameters on FDS.
Collected BSB-GW-01 at 0951
1-250mL /Filt/$HNO_3$/Diss metals + Hg
1-250mL/$H_2SO_4$/$NO_2$-$NO_3$, COD
1-250mL/ NaOH /Cyanide
1-500mL/ NaOH Zinc Acetate /sulfide.
3-40mL /VOC's 8260B /HCL
1-1L / Raw/PH/SC/$CL^-$/$SO_4^{-2}$
Left site at 1015
Decon Next Location. at 1030

BSB-A1 arrived at 1100
DTW: 39.06' T.D.: 57.00'
Dedicated tubing
Purged with SS. 12V pump
Purge rate - 0.6 gpm for 6mins then 0.5 gpm
Start purging: 1106
Stop purging: 1128
Total purged: ~~10.1~~ 11.6 gal NF
Field Parameters on FDS
Collected BSB-GW-02 at 1128
(See page 132)

Rite in the Rain

3-23-22

1-1L Raw/PH/SC/CL/$SO_4^{-2}$
1-250mL $H_2SO_4$/$NO_2$-$NO_3$/COD
1-250mL NaOH/Cyanide
3-40mL HCL / 8260B VOC's
1-500mL NaOH zincAcetate/Sulfide
Decon at 1138 then Left site at 1158

BSB-A5 Arrived at 1220
DTW: 45.50' T.D.: 45.60'
Bailer.
1224 tried to Bail but DTW is to Low to get any water out. No samples were collected. PMO

BSB-A6R Arrived at 1315
DTW: 52.33' T.D.: 59.75'
Dedicated tubing
Purged with S.S. 12V pump
purge rate: 0.117 gpm
start purge: 1330
stop purge: 1430
Total purge: 7.02 gal

3-23-22
Field parameters on FDS

Collected BSB-GW-04 at 1430
1-1L Raw PH/SC/CL/$SO_4^{-2}$
1250mL $H_2SO_4$/$NO_2$-$NO_3$/COD
1-250mL NaOH/Cyanide
3-40mL HCL/8260B VOC's
1-500mL NaOH zinc Acetate/Sulfide

Collected BSB-GW-07 at 1445 of 1420
3-40mL HCL VOC's 8260B
Deconned pump then offsite 1520
Ran to CLK-2 to do Blank, after bailer well.
Collected BSB-GW-09 at 1255
1-1L Raw PH/SC/CL/$SO_4^{-2}$
1-250mL Filt $HNO_3$/ Diss Metals + Hg

Collected blank at A6R as well.
Collected BSB-GW-10 at 1320
1-1L Raw PH/SC/CL/$SO_4^{-2}$
1-250mL Filt / $HNO_3$/ Diss Metals + Hg
3-40mL HCL/8260B VOC's.
Samples stored In Fridge at end of day. JH/NF offsite at 1520 per toolbox form. PMO

3/24/22

Shipped Samples

1500 → Pioneer dropped off 2 coolers with samples at FedEx and sent to Pace Analytical Lab.

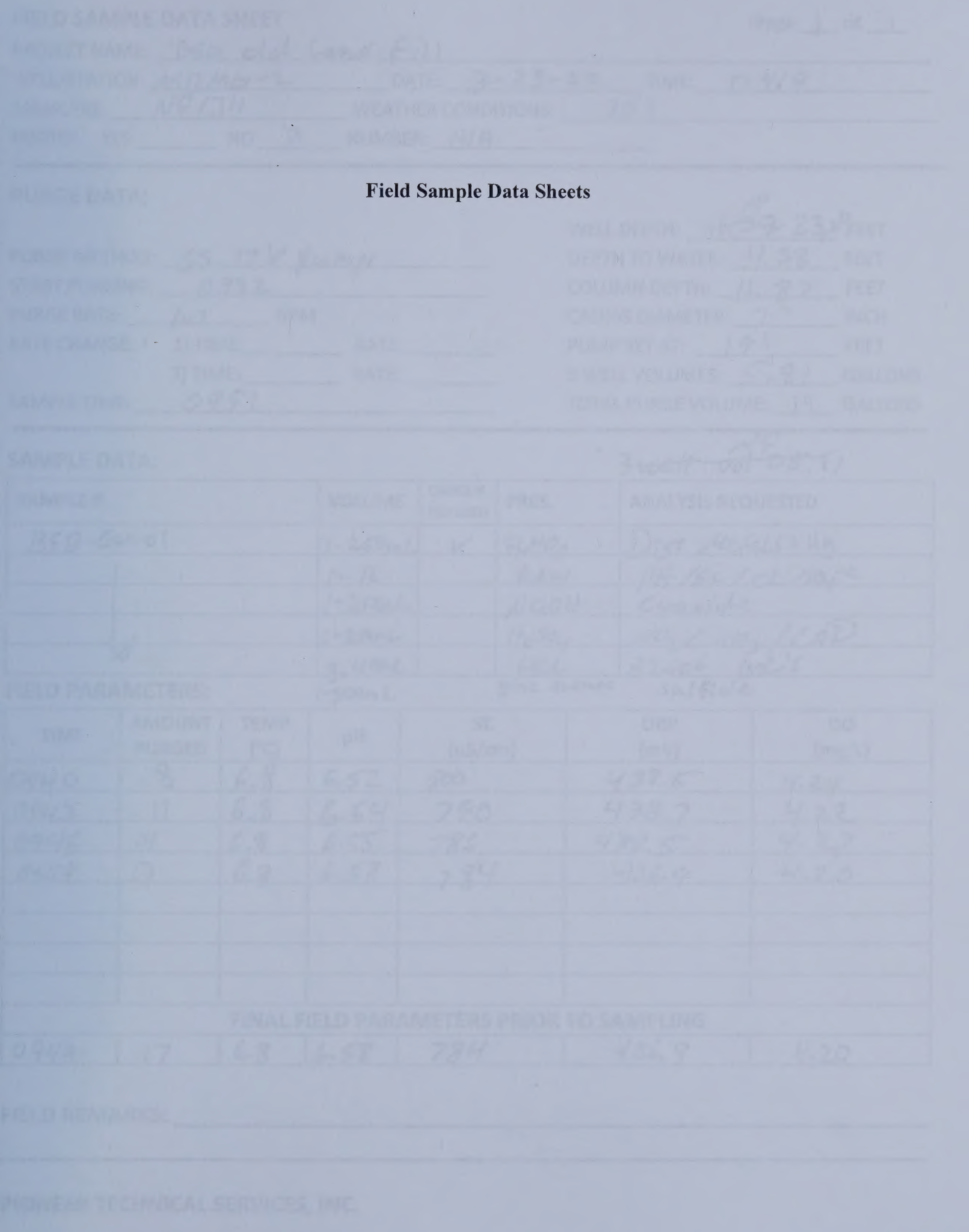
Tracking #'s: 540518177224 → Delivered on 3/25/22
540518177143 → Delivered on 3/25/22

4/28/22

the Pace Analytical Lab report showed the incorrect sampling date for sample BSB-GW-09 (field blank for Clark Tailings). PMO contacted Pace Analytical Lab and they revised the report to show the correct sampling date (3/23/22). the revised report was received on 4/28/22. Pace Analytical Lab will upload the revised report to BP's database.

Patricia Olson
4/28/22

# Field Sample Data Sheets



## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB old Land Fill
WELL/STATION: MBMG-2 DATE: 3-23-22 TIME: 0919
SAMPLERS: NF/JH WEATHER CONDITIONS: 30's
PHOTO: YES ______ NO X NUMBER: N/A

---

## PURGE DATA:

WELL DEPTH: ~~11.38~~ NF 23.20 FEET
PURGE METHOD: SS 12V pump
DEPTH TO WATER: 11.38 FEET
START PURGING: 0932
COLUMN DEPTH: 11.82 FEET
PURGE RATE: 1.0 GPM
CASING DIAMETER: 2" INCH
RATE CHANGE: 1) TIME: ______ RATE: ______
PUMP SET AT: 19' FEET
2) TIME: ______ RATE: ______
3 WELL VOLUMES: 5.91 GALLONS
SAMPLE TIME: 0951
TOTAL PURGE VOLUME: 19 GALLONS

---

## SAMPLE DATA:

~~3well vol ~5.91~~ NF

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-01 | 1-250mL | ✓ | $HNO_3$ | Diss Metals + Hg |
|  | 1-1L |  | RAW | pH/SC/CL/$SO_4^{-2}$ |
|  | 1-250mL |  | NaOH | Cyanide |
|  | 1-250mL |  | $H_2SO_4$ | $NO_2$/$NO_3$/COD |
|  | 3-40mL |  | HCL | 82606 VOC's |
|  | 1-500mL |  | Zinc Acetate | sulfide |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 0940 | 8 | 6.8 | 6.52 | 800 | 438.5 | 4.24 |
| 0943 | 11 | 6.8 | 6.64 | 790 | 438.7 | 4.22 |
| 0946 | 14 | 6.8 | 6.55 | 786 | 438.5 | 4.27 |
| 0949 | 17 | 6.8 | 6.58 | 784 | 436.9 | 4.20 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** |  |  |  |  |  |  |
| 0949 | 17 | 6.8 | 6.58 | 784 | 436.9 | 4.20 |

FIELD REMARKS: ______

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB -old Landfill

WELL/STATION: BSB-A1 DATE: 3-23-22 TIME: ~~[illegible]~~ NF 1050

SAMPLERS: NF/JH WEATHER CONDITIONS: 40's

PHOTO: YES ____ NO x NUMBER: N/A

## PURGE DATA:

PURGE METHOD: SS 12v pump

START PURGING: 1106

PURGE RATE: 0.6 GPM ~6 mins 3.6 gal

RATE CHANGE: 1) TIME: 1112 RATE: 0.5 gpm

2) TIME: ____ RATE: ____

SAMPLE TIME: 1128

WELL DEPTH: 57.00 FEET

DEPTH TO WATER: 39.06 FEET

COLUMN DEPTH: 17.94 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 55 FEET

3 WELL VOLUMES: 8.97 GALLONS

TOTAL PURGE VOLUME: 11.6 GALLONS

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-02 | 1-1L | · | Raw | PH/SC/CL/$SO_4^{-2}$ |
| ↓ | 1-250ml | | $H_2SO_4$ | $NO_2$-$NO_3$ COD |
| ↓ | 1-250ml | | ~~$HNO_3$~~ NF NaOH | Cyanide |
| ↓ | 3-40mL | | HCL | 8260b VOC's |
| ↓ | 1-500ml | | Zinc Acetate | Sulfide |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1116 | 5.6 | 9.0 | 6.57 | 437.3 | 484.9 | 0.28 |
| 1119 | 7.1 | 9.0 | 6.59 | 434.5 | 481.8 | 0.20 |
| 1122 | 8.6 | 9.1 | 6.62 | 436.3 | 474.2 | 0.20 |
| 1125 | 10.1 | 9.0 | ~~[illegible]~~ 6.65 NF | 436.1 | 466.0 | 0.19 |
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| ~~0949~~ 1125 | 10.1 | 9.0 | 6.65 | 436.1 | 466.0 | 0.19 |

FIELD REMARKS: Decon pump 1138 start

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB-Old Landfill

WELL/STATION: BSB-A5 DATE: JH ~~5-9-~~ 3/23/22 TIME: 1220

SAMPLERS: JH NF WEATHER CONDITIONS: 40-50F Sunny

PHOTO: YES ____ NO X NUMBER: N/A

### PURGE DATA:

WELL DEPTH: 45.60 FEET

DEPTH TO WATER: 45.50 FEET

COLUMN DEPTH: 0.10 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: — FEET

3 WELL VOLUMES: 0.05 GALLONS

TOTAL PURGE VOLUME: — GALLONS

PURGE METHOD: Bailer

START PURGING: 1224

PURGE RATE: ____ GPM

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: ____

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| N/A | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| N/A | | | | | | |
| | | | | | | |
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| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| | | | | | | |

FIELD REMARKS: Not Enough water to purge or collect samples. Effectively Dry

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 2

PROJECT NAME: BSB - Old Landfill

WELL/STATION: BSB-A6R DATE: 3/23/22 TIME: 1315

SAMPLERS: JH NF WEATHER CONDITIONS:

PHOTO: YES ______ NO X NUMBER: N/A

---

### PURGE DATA:

PURGE METHOD: S.S. 12v pump

START PURGING: 1330

PURGE RATE: 0.117 GPM

RATE CHANGE: 1) TIME: ______ RATE: ______

2) TIME: ______ RATE: ______

SAMPLE TIME: 1430 Dupe - 1420

WELL DEPTH: 59.75 FEET

DEPTH TO WATER: 52.33 FEET

COLUMN DEPTH: 7.42 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 58 FEET

3 WELL VOLUMES: 3.71 GALLONS

TOTAL PURGE VOLUME: 7.02 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-04 | 1-250mL | NF X | $H_2SO_4$ | $NO_2^-$ $NO_3$ / ~~X~~ NF COD |
| ↓ | 1-250mL | | NaOH | Cyanide |
| | 1-500mL | | ~~Raw~~ NF Zinc Acetate | Sulfide |
| | 3-40mL | | HCL | VOC's 8260b |
| | 1-1L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

**FIELD PARAMETERS:** BSB-GW-07 3-40mL HCL VOC's 8260b

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1358 | NF 3.276 | 11.5 | 5.71 | 4738 | 133.4 | 1.44 |
| 1401 | 3.6~~27~~ 702 | 11.6 | 5.72 | 4852 | 125.2 | 1.40 |
| 1404 | ~~3.744~~ 4.053 | 11.6 | 5.71 | 4920 | 118.0 | 1.35 |
| 1407 | ~~3.84~~ 4.404 | 11.0 | 5.72 | 5121 | 112.3 | 0.65 ↖ Air bubble |
| 1410 | ~~3.478~~ 4.755 | 11.1 | 5.75 | 5301 | 103.7 | 0.73 |
| 1413 | ~~4.045~~ 5.106 | 11.0 | 5.74 | ~~5467~~ 5767 | 102.5 | 0.89 |
| 1416 | ~~4.212~~ 5.457 | 10.8 | 5.76 | 5367 | 98.9 | 0.89 |
| 1419 | ~~4.329~~ 5.808 | 10.8 | 5.77 | 5244 | 92.6 | 0.87 |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | ↖ see pg 2 for parameters |
| 1428 | | 11.0 | 5.82 | 5429 | 76.2 | 0.96 |

FIELD REMARKS: Collected field blank BSB-GW-10 at 1320

Got very turbid again at 1416

Collected BSB-GW-07 @ 1420

1255

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 2 of 2

PROJECT NAME: BSB-old Landfill

WELL/STATION: BSB-A6R DATE: TIME:

SAMPLERS: WEATHER CONDITIONS:

PHOTO: YES NO NUMBER:

## PURGE DATA:

NF

PURGE METHOD:

START PURGING:

PURGE RATE: GPM

RATE CHANGE: 1) TIME: RATE:

2) TIME: RATE:

SAMPLE TIME:

WELL DEPTH: FEET

DEPTH TO WATER: FEET

COLUMN DEPTH: FEET

CASING DIAMETER: INCH

PUMP SET AT: FEET

3 WELL VOLUMES: GALLONS

TOTAL PURGE VOLUME: GALLONS

## SAMPLE DATA:

See Pg 1

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 34 1422 | NF 6.159 ~~4.446~~ | 10.8 | 5.29 | 5680 | 83.7 | 0.89 |
| 135 1425 | 6.570 ~~4.543~~ | 11.0 | 5.81 | 5542 | 80.0 | 0.97 |
| 36 1428 | 6.861 ~~4.780~~ | 11.0 | 5.82 | 5429 | 76.2 | 0.96 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1428 | | 11.0 | 5.82 | 5429 | 76.2 | 0.96 |

FIELD REMARKS:

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB-old landfill / clark tailings

WELL/STATION: CLK-1 DATE: 3/22/22 TIME: 1055

SAMPLERS: JH NF WEATHER CONDITIONS: 36° partly cloudy

PHOTO: YES ______ NO X NUMBER: N/A

---

## PURGE DATA:

WELL DEPTH: 19.00 FEET

PURGE METHOD: 3 stage dedicated pump

DEPTH TO WATER: 6.56 FEET

START PURGING: 1103

COLUMN DEPTH: 12.44 FEET

PURGE RATE: 0.2 GPM

CASING DIAMETER: 2 INCH

RATE CHANGE: 1) TIME: ______ RATE: ______

PUMP SET AT: 15 FEET

2) TIME: ______ RATE: ______

3 WELL VOLUMES: 6.22 GALLONS

SAMPLE TIME: 1138

TOTAL PURGE VOLUME: 7.0 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-05 | 1-250 mL | ✓ | $HNO_3$ | Dissolved metals + Hg |
| BSB-GW-05 | 1-1L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| | | | | |
| BSB-GW-08 | 1-250mL | ✓ | $HNO_3$ | Dissolved metals + Hg |
| BSB-GW-08 | 1-1L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1124 | 4.2 | 7.8 | 6.36 | 1761 | 121.3 | 1.05 |
| 1127 | 4.8 | 7.8 | 6.38 | 1764 | 115.1 | 0.45 |
| 1130 | 5.4 | 8.3 | 6.36 | 1763 | 109.7 | 0.35 |
| 1133 | 6.0 | 8.2 | 6.36 | 1765 | 105.4 | 0.32 |
| 1136 | 6.6 | 8.2 | 6.36 | 1760 | 101.8 | 0.32 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1136 | 6.6 | 8.2 | 6.36 | 1760 | 101.8 | 0.32 |

FIELD REMARKS: Collected BSB-GW-~~08~~ 08 NF (Dupe) at 1145

Deconned @ 1150

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB old landfill / Clark tailings

WELL/STATION: Clark 2 (CLK-2) DATE: 3/22/22 TIME: 9:30

SAMPLERS: JH NF WEATHER CONDITIONS: 34° cloudy

PHOTO: YES ______ NO X NUMBER: N/A

---

### PURGE DATA:

PURGE METHOD: 3 Stage dedicated pump

START PURGING: 0941

PURGE RATE: .08 GPM

RATE CHANGE: 1) TIME: ______ RATE: ______

2) TIME: ______ RATE: ______

SAMPLE TIME: 1023

WELL DEPTH: 46.90 FEET

DEPTH TO WATER: 42.27 FEET

COLUMN DEPTH: 4.63 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 45 FEET

3 WELL VOLUMES: 2.315 GALLONS

TOTAL PURGE VOLUME: 3.36 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-06 | 1-250mL | ✓ | $HNO_3$ | Dissolved metals + Hg |
| BSB-GW-06 | ~~1-500mL~~ JH<br>1-1L | | Raw | pH, SC, $CL^-$, $SO_4^{-2}$ |
| | | | | |
| | | | | |

### FIELD PARAMETERS:

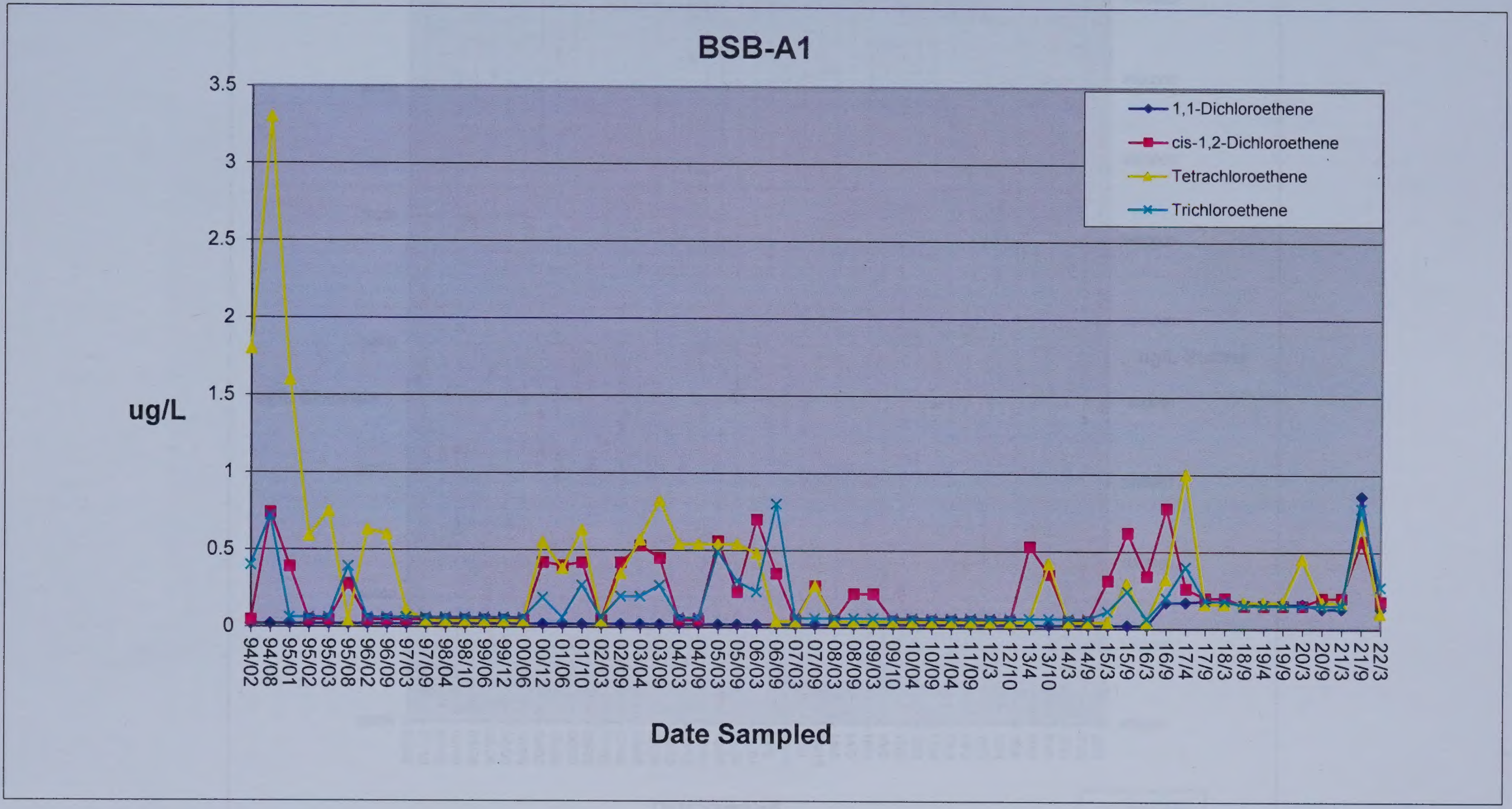
| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1013 | 2.56 | 10.1 | 6.31 | 1518 | 274.6 | 0.94 |
| 1016 | 2.80 | 10.3 | 6.32 | 1516 | 273.8 | 0.99 |
| 1019 | 3.04 | 10.3 | 6.32 | 1515 | 273.0 | 1.01 |
| 1022 | 3.28 | 10.3 | 6.32 | 1512 | 272.1 | 1.04 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1022 | 3.28 | 10.3 | 6.32 | 1512 | 272.1 | 1.04 |

FIELD REMARKS: Clark tailings field blank was collected as sample BSB-GW-09 on 3/23/22. PMO

**PIONEER TECHNICAL SERVICES, INC.**

## Analytical Results from Pace Analytical Services, LLC
## (Included Electronically with this Letter)

# Water Quality Trend Graphs


BSB-A1
ug/L
3.5
3
2.5
2
1.5
1
0.5
0
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
97/09
98/04
98/10
99/06
99/12
00/06
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16/9
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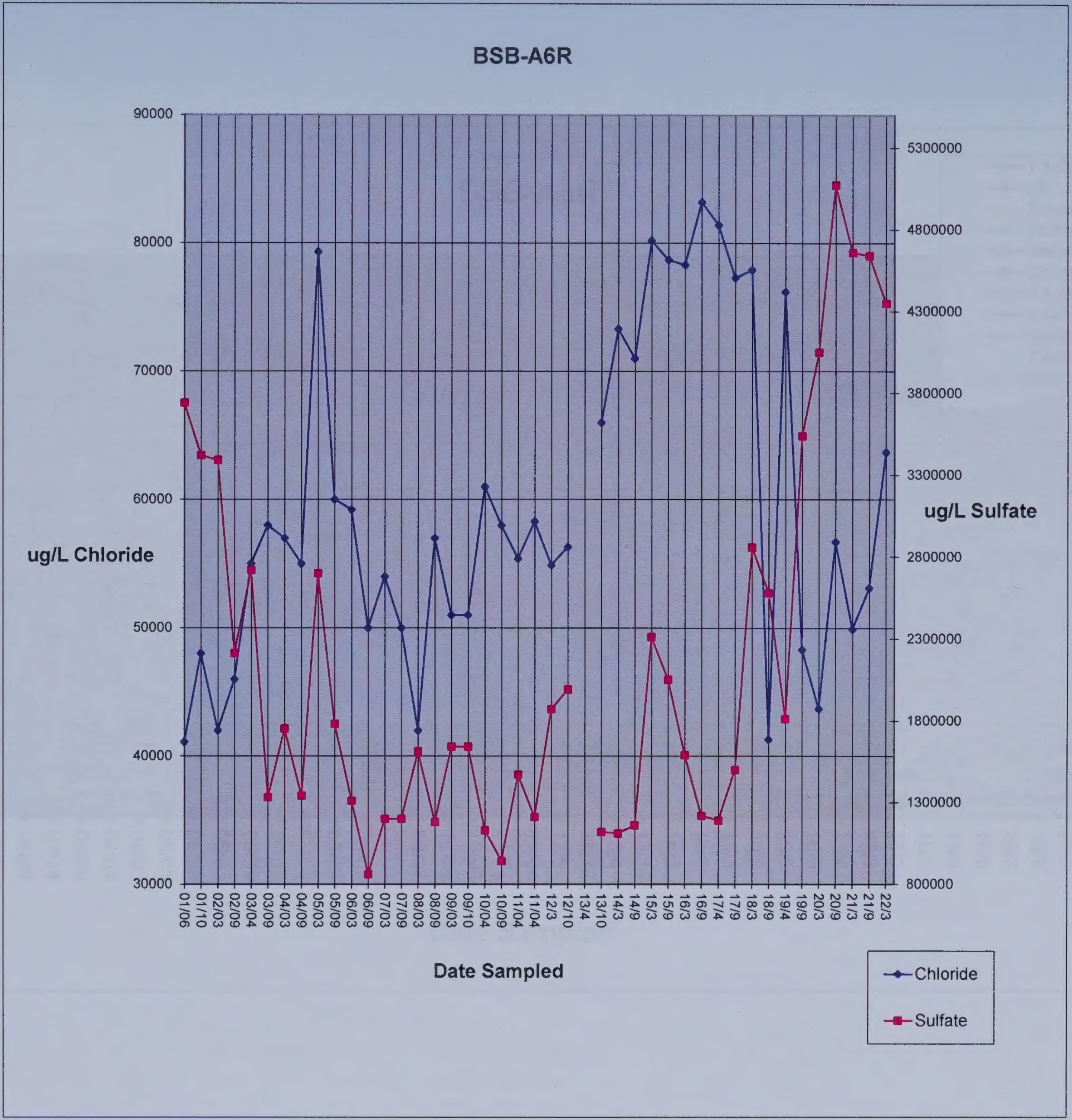
22/3
Date Sampled


BSB-A6R
ug/L Chloride
90000
80000
70000
60000
50000
40000
30000
ug/L Sulfate
5300000
4800000
4300000
3800000
3300000
2800000
2300000
1800000
1300000
800000
01/06
01/10
02/03
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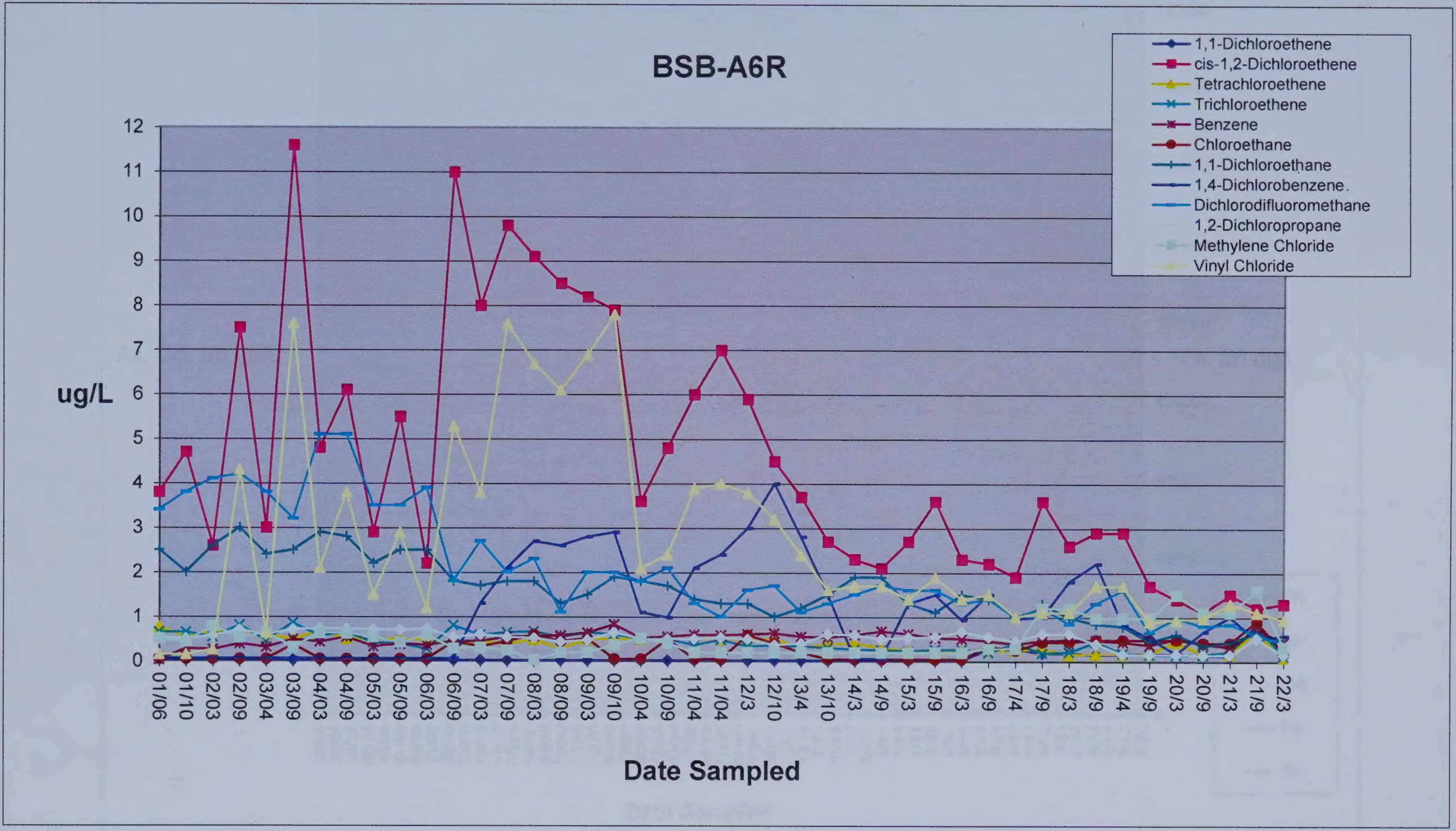
22/3
Date Sampled
Chloride
Sulfate


BSB-A6R
ug/L
12
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1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride
01/06
01/10
02/03
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03/04
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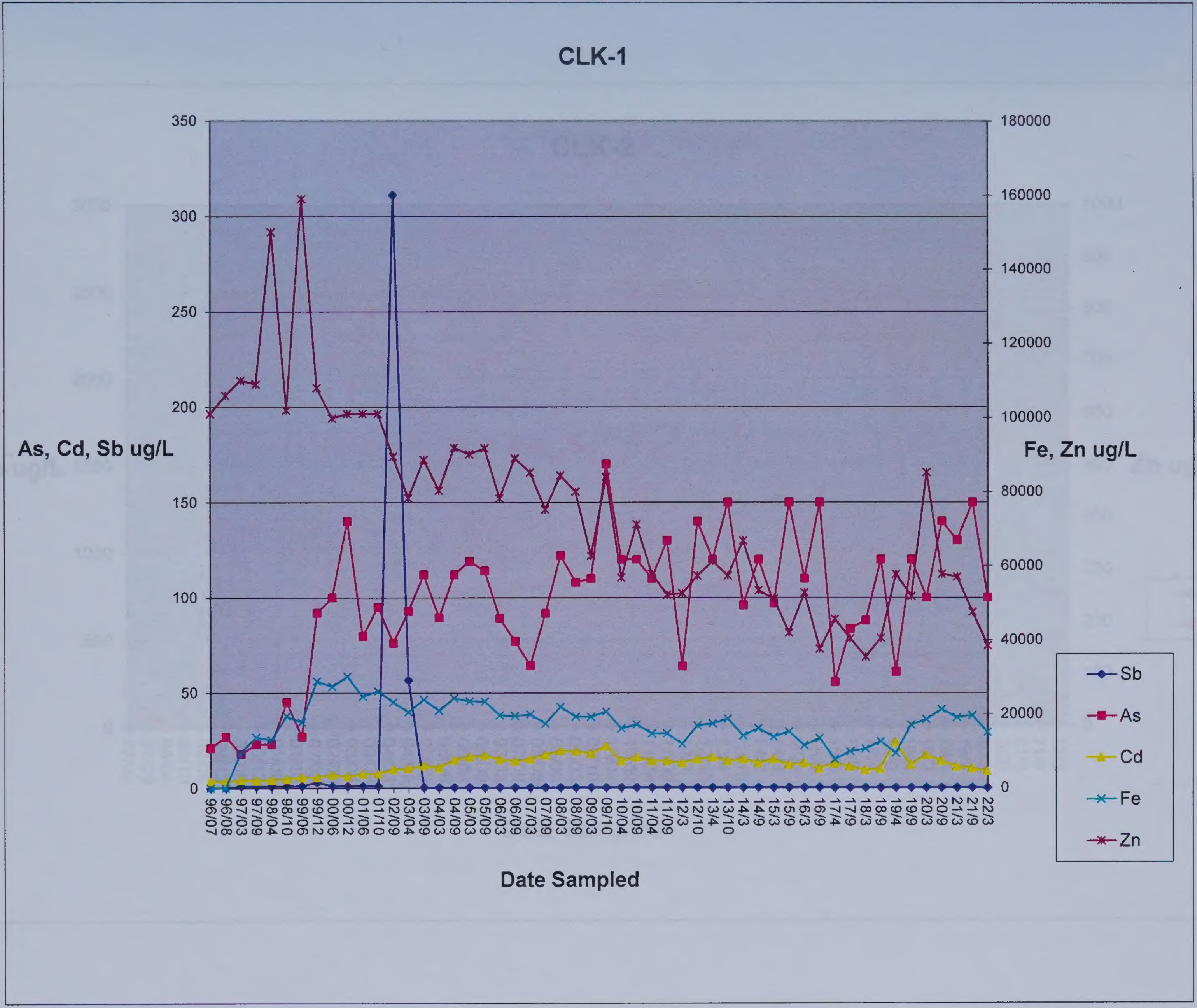
Date Sampled


CLK-1
As, Cd, Sb ug/L
350
300
250
200
150
100
50
0
Fe, Zn ug/L
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
96/07
96/08
97/03
97/09
98/04
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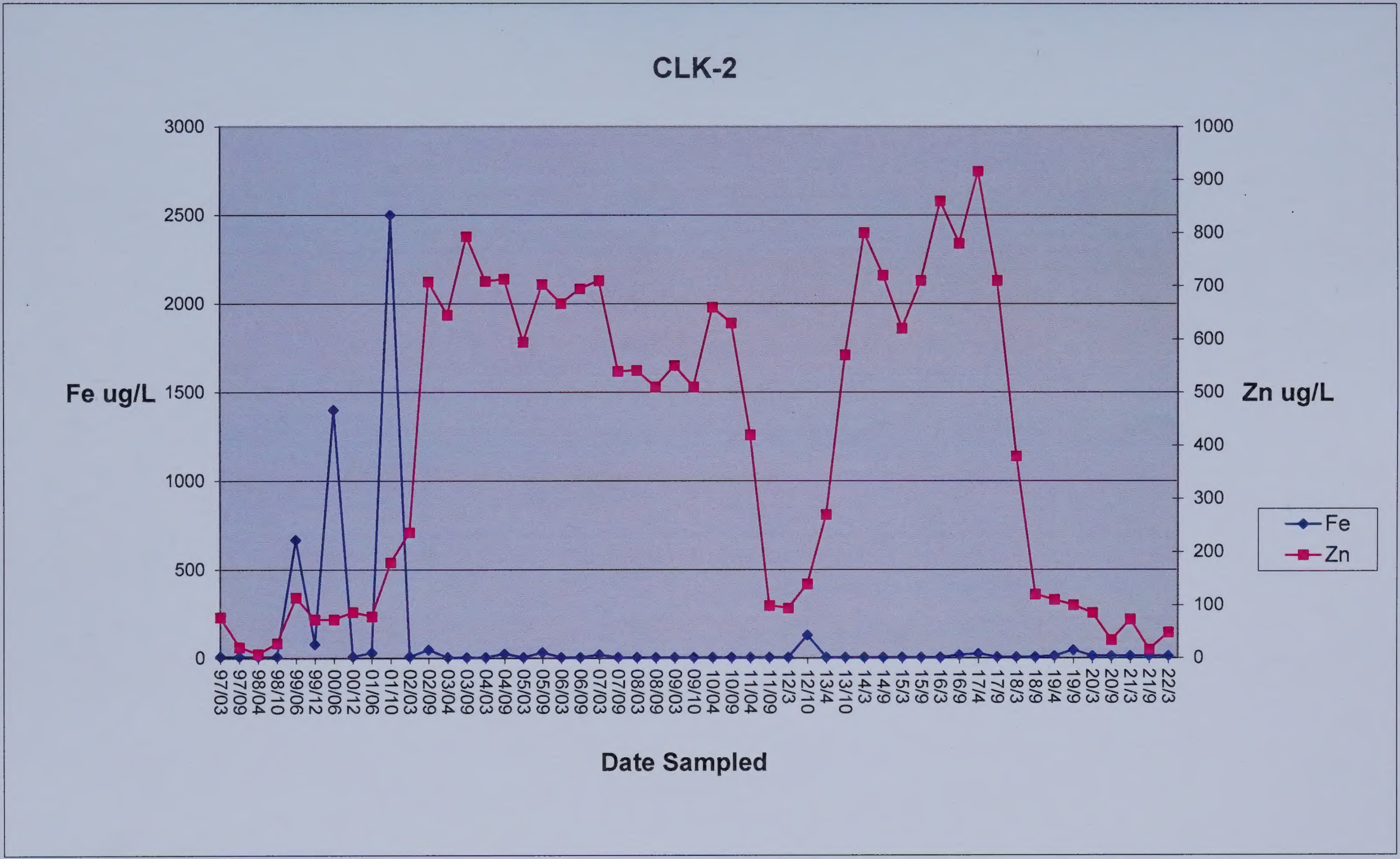
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
Fe ug/L
Zn ug/L
Date Sampled
3000
2500
2000
1500
1000
500
0
1000
900
800
700
600
500
400
300
200
100
0
97/03
97/09
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21/9
22/3
Fe
Zn

PIONEER
TECHNICAL SERVICES, INC.

County Silver Bow
Facility & # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run-on

November 12, 2019

Mr. Mike Eder
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear Mr. Eder:

On September 17 and 18, 2019, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring for the Butte-Silver Bow (BSB) Closed Landfill and Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from four monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

- A figure showing the location of the groundwater monitoring wells (Figure 1).
- The Groundwater Potentiometric Surface Map for September 2019 (Figure 2).
- A document comparing the September 2019 results to previous results, maximum baseline and background concentrations, and groundwater protection standards (Attachment 1).
- A table comparing the September 2019 analytical data to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards (Table 1).
- A table showing the groundwater monitoring data and a non-parametric comparison of the monitoring wells (Table 2) (included electronically with this letter).
- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- Copy of field notes and field sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2.

PIONEER
TECHNICAL SERVICES, INC.

November 12, 2019

RECEIVED
NOV 15 2019
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Mr. Mike Eder
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

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- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2.

The following sections provide a summary of the groundwater velocity calculations and statistical analysis conducted by Pioneer for the BSB Closed Landfill and Clark Tailings site.

**Groundwater Velocity Calculations**

Using the depth-to-groundwater measurements collected during the September 2019 monitoring event, a groundwater potentiometric surface map was developed (Figure 2). Based on Figure 2, groundwater flows in a northern direction at a hydraulic gradient ranging from 0.0333 feet per foot (ft/ft) to 0.0319 ft/ft. This is consistent with the past groundwater flow direction and range of hydraulic gradients. Using the hydraulic gradients, two groundwater velocities were calculated using both Darcy's Law and the equation for the seepage velocity. The average groundwater velocity for the September 2019 sampling event was 0.307 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the average groundwater velocity was acquired from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

**Water Quality Results**

The September 2019 sampling event at the BSB Closed Landfill and Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the EPA's Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The September 2019 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well [MBMG-2]) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

The results from the September 2019 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6-R, CLK-1, and CLK-2 exceeded the EPA's Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years.

Please refer to Attachment 1 for a summary of the September 2019 results.

**Statistical Analysis**

Pioneer has calculated a confidence level of 98.1% per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

If you have any questions or concerns, please contact me at (406) 497-8056.

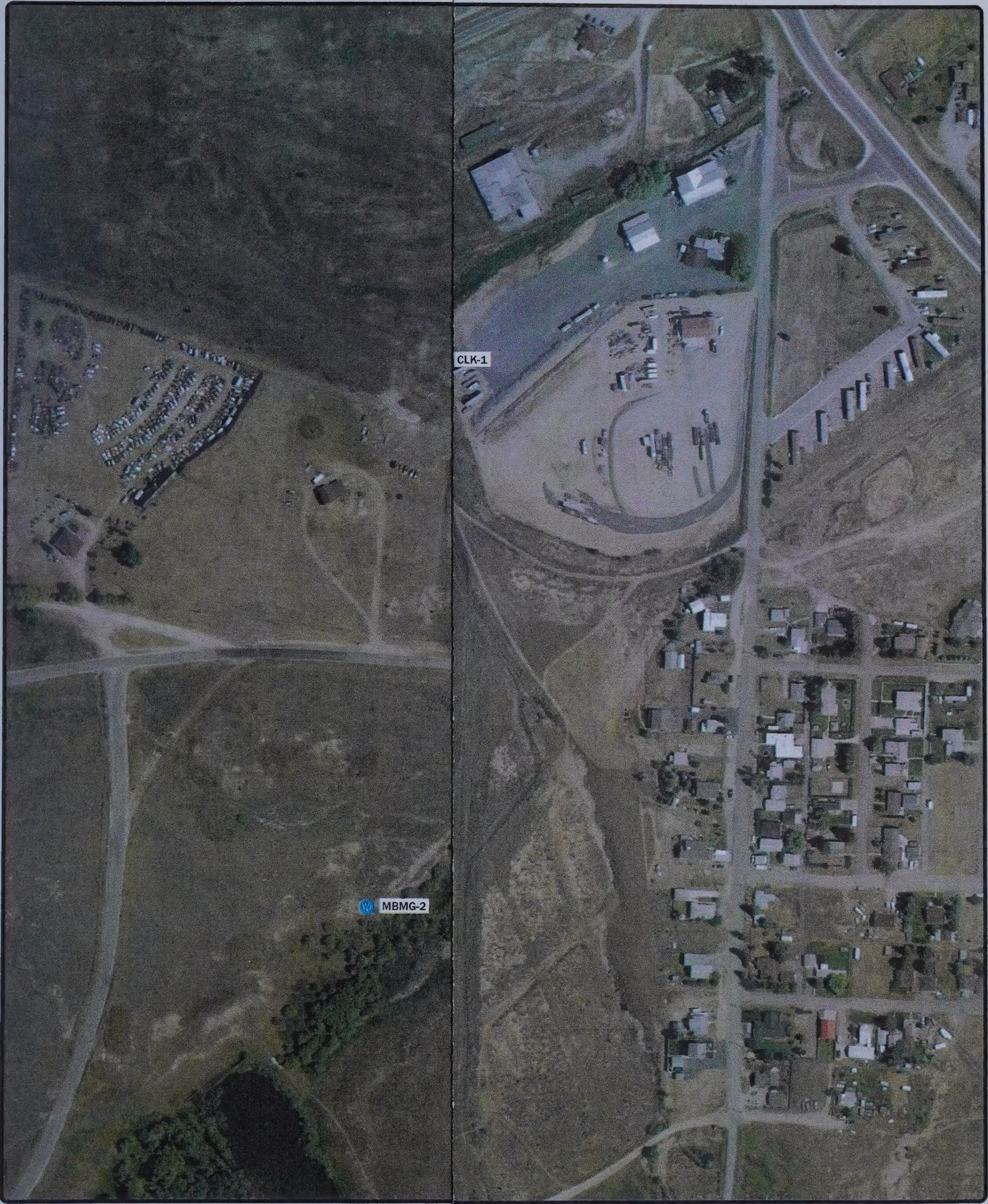
Sincerely,

Patricia Olson

Patty Olson
Project Engineer

Encl.

cc: Mark Neary, BSB Public Works Director
Glen Rafish, BSB Landfill Manager
Joseph S. McElroy, Pioneer Project Manager (email)
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Josh Bryson, Atlantic Richfield (email)
Loren Burmeister, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com



LEGEND

W GROUNDWATER MONITORING WELLS

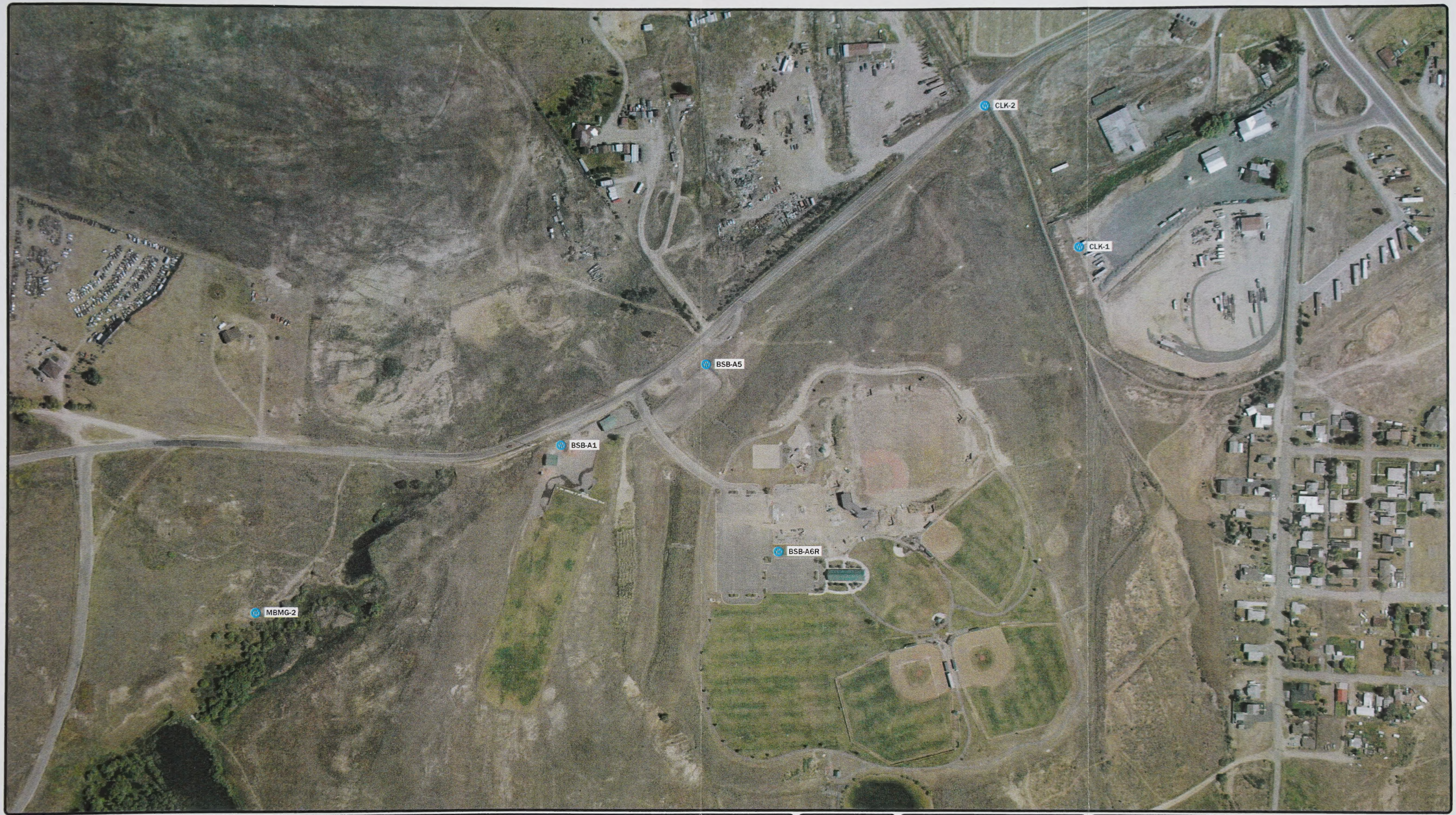
FIGURE 1

## BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - L



LEGEND

🟦 GROUNDWATER MONITORING WELLS

N

| | DISPLAYED AS: |
|---|---|
| COORD SYS/ZONE: | MSP83 |
| DATUM: | NAVD88 |
| UNITS: | IF |
| SOURCE: | PIONEER/AES |

SCALE IN FEET
0 100 200

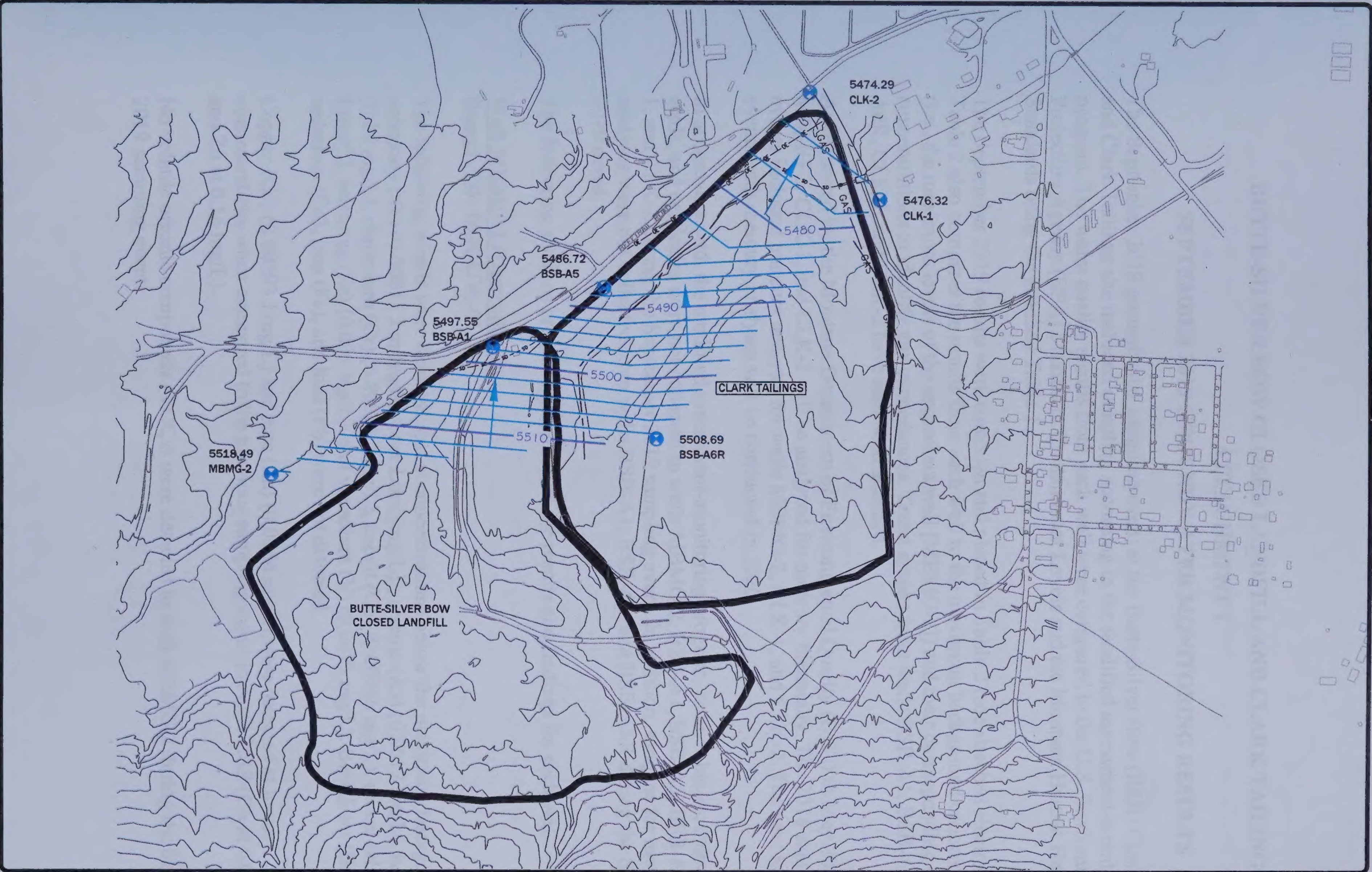
FIGURE 1

# BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-001-18.DWG


5474.29
CLK-2
5476.32
CLK-1
5480
5486.72
BSB-A5
5490
5497.55
BSB-A1
5500
5510
5508.69
BSB-A6R
5518.49
MBMG-2
CLARK TAILINGS
BUTTE-SILVER BOW
CLOSED LANDFILL
GAS

## LEGEND

CLK-1 ● GROUNDWATER MONITORING WELL

— CONTOUR, INTERVAL = 10'

═ GROUNDWATER CONTOURS

N

| | DISPLAYED AS: |
|---|---|
| COORD SYS/ZONE: | NA |
| DATUM: | NA |
| UNITS: | FEET |
| SOURCE: | PIONEER |

SCALE IN FEET

0 300 600

# FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

# BSB CLOSED LANDFILL AND CLARK TAILINGS GROUNDWATER POTENTIOMETRIC SURFACE MAP SEPTEMBER 2019

DATE: 10/2019

11/6/2019 11:13:31 AM P:\BUTTE-SILVER BOW\2019\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\SEPTEMBER 2019 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-SEP-PLN-001-19.DWG

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## ATTACHMENT 1
## SEPTEMBER 2019 GROUNDWATER MONITORING RESULTS

The September 2019 groundwater sampling event at the Butte-Silver Bow (BSB) Closed Landfill and Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The September 2019 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well [MBMG-2]) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

As requested by the Montana Department of Environmental Quality (DEQ) in May 2013, wells MBMG-2, CLK-1, and CLK-2 will be analyzed for mercury biennially. The 2018 sampling events included mercury analysis for wells MBMG-2, CLK-1, and CLK-2. The next monitoring events with mercury analyses will be conducted in 2020.

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in wells MBMG-2, BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 during the September 2019 sampling event. In addition, samples for metals analyses were not collected from wells BSB-A1, BSB-A5, and BSB-A6R during the September 2019 event.

The following sections provide a summary of the results and findings for each well.

**Well MBMG-2 (Upgradient):**
**Sample ID: BSB-GW-01**

The following metals were detected, but at concentrations below the maximum background: antimony (Sb) (0.00011 J milligrams per Liter [mg/L]), arsenic (As) (0.0012 mg/L), barium (Ba) (0.14 mg/L), chromium (Cr) (0.00038 J mg/L), cobalt (Co) (0.00066 mg/L), nickel (Ni) (0.00035 J mg/L), selenium (Se) (0.001 mg/L), and vanadium (V) (0.0073 mg/L). Beryllium (Be), cadmium (Cd), iron (Fe), and lead (Pb) were not detected.

Copper (Cu) (0.00093 J mg/L) and zinc (Zn) (0.0084 mg/L) were detected at lower concentrations when compared to the previous sampling event in April 2019 (Cu at 0.085 mg/L and Zn at 0.16 mg/L).

No volatile organic compounds (VOCs) were detected in well MBMG-2 during the September 2019 sampling event.

Nitrate/nitrite (5.0 mg/L), chloride (71.5 mg/L), specific conductance (816 micromhos per centimeter [umhos/cm]), and sulfate (133 mg/L) were detected, but at concentrations below the maximum background.

Analytical results from well MBMG-2 did not exceed any of the EPA's Maximum Contaminant Levels or the Montana Human Health Standards during the September 2019 sampling event.

**Well BSB-A1 (North Well):**
**Sample ID: BSB-GW-02**

Volatile organic compounds were not detected in well BSB-A1 during the September 2019 sampling event.

Nitrate/nitrite (0.29 mg/L), chloride (19.7 mg/L), sulfate (81.6 mg/L), and specific conductance (478 umhos/cm) were detected, but at concentrations below the maximum background.

The September 2019 results from well BSB-A1 were compared to the EPA's Maximum Contaminant Levels and the Montana Human Health Standards and no exceedances were observed.

The results from September 2019 are consistent with the results from April 2019.

**Well BSB-A5 (Northeast Well):**
**Sample ID: BSB-GW-03**

Levels of cis-1,2-Dichloroethene (4.1 micrograms per Liter [µg/L]) were above the maximum background concentrations. Vinyl Chloride (2.4 µg/L) was detected above the maximum baseline and background concentrations. The following VOCs were also detected, but at concentrations below the maximum baseline and background concentrations: Benzene (0.33 J µg/L), 1,1-Dichloroethane (0.34 J µg/L), Tetrachloroethene (0.57 J µg/L), and Trichloroethene (0.96 µg/L). The attached trend graph for well BSB-A5 shows that the levels of cis-1,2-Dichloroethene, Tetrachloroethene, and Trichloroethene are lower than the results from April 2019.

Specific conductance (1,340 umhos/cm) and sulfate (601 mg/L) were detected above the maximum background concentrations, and chloride (68.0 mg/L) was detected above the maximum baseline concentration.

Results from the September 2019 sampling event also show that the levels of sulfate (601 mg/L) exceeded the EPA's Maximum Contaminant Level (250 mg/L), and the levels of Vinyl Chloride (2.4 µg/L) exceeded the EPA's Maximum Contaminant Level (2.0 µg/L) and Montana Human Health Standard (0.2 µg/L).

**Well BSB-A6R (Central Well):**
**Sample ID: BSB-GW-04**

Well BSB-A6R is the replacement well for BSB-A6, which was removed during construction of the Timber Butte Youth Park.

The following VOCs were detected in well BSB-A6R during the September 2019 sampling event:

- Benzene (0.37 J µg/L).
- 1,4-Dichlorobenzene (0.52 J µg/L).
- Dichlorodifluoromethane (0.65 J µg/L).
- 1,1-Dichloroethane (0.45 J µg/L).
- cis-1,2-Dichloroethene (1.7 µg/L) exceeds the maximum background concentration.
- Vinyl Chloride (0.89 µg/L) exceeds the maximum background concentration and the Montana Human Health Standard (0.2 µg/L).

The attached trend graphs for well BSB-A6R indicate that the VOC results are lower than the results from previous sampling events.

Sulfate (3,540 mg/L), specific conductance (4,950 umhos/cm), and chemical oxygen demand (605 mg/L) were detected above the maximum background concentrations and were significantly higher than the results from April 2019. Chloride (48.3 mg/L) was detected, but at concentrations below the maximum baseline and background concentrations. The attached trend graphs for well BSB-A6R show that the levels of chloride (48.3 mg/L) decreased significantly when compared to the April 2019 levels (76.2 mg/L) but were similar to the September 2018 levels (41.3 mg/L).

Results from the September 2019 sampling event also show that the levels of sulfate (3,540 mg/L) exceeded the EPA's Maximum Contaminant Level (250 mg/L).

**Well CLK-1 (Clark Tailings East Well):**
**Sample ID: BSB-GW-05**

Metals detected above the maximum background concentrations, but below the maximum baseline concentrations include: As (0.12 mg/L), Cd (0.012 mg/L), Co (0.044 mg/L), Fe (17.0 mg/L), Ni (0.038 mg/L), and Zn (51.8 mg/L).

Antimony (0.00013 J mg/L), Ba (0.026 mg/L), Be (0.00034 mg/L), Cu (0.0041 mg/L), Pb (0.000076 J mg/L), and V (0.00047 J mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Chromium and Se were not detected.

Arsenic, Cd, Fe, and Zn also exceeded the EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

The levels of sulfate (850 mg/L) and specific conductance (1,820 umhos/cm) exceeded the maximum background concentrations. Chloride (32.8 mg/L) was detected, but at concentrations

below the maximum baseline and background. The levels of sulfate (850 mg/L) were also higher than the EPA's Maximum Contaminant Level (250 mg/L).

The attached trend graph for well CLK-1 shows that the results for As and Fe increased, while the results for Cd and Zn decreased when compared to the previous sampling event.

**Well CLK-2 (Clark Tailings North Well):**
**Sample ID: BSB-GW-06**

The attached trend graph for well CLK-2 indicates that the levels of Zn (0.10 mg/L) were similar to the April 2019 results. The levels of Zn have been decreasing significantly since April 2017 as the trend graph shows.

Antimony (0.00016 J mg/L), As (0.0028 mg/L), Ba (0.013 mg/L), Cd (0.00016 mg/L), Cr (0.00063 mg/L), Co (0.00029 J mg/L), Cu (0.0029 mg/L), Fe (0.045 J mg/L), Ni (0.006 mg/L), Se (0.00031 J mg/L), and V (0.0032 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Beryllium and Pb were not detected.

Sulfate (407 mg/L) and specific conductance (1,220 umhos/cm) exceeded the maximum background concentrations. Chloride (39.2 mg/L) was detected, but at concentrations below the maximum baseline and background concentrations. The level of sulfate (407 mg/L) was also higher than the EPA's Maximum Contaminant Level (250 mg/L).

**Summary:**

The September 2019 groundwater sampling event at the BSB Closed Landfill and Clark Tailings site included sampling according to the modified assessment-monitoring program. Using the attached Table 1, Table 2 and trend graphs, the September 2019 results were compared to previous results, maximum baseline and background concentrations, and the EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Results from well MBMG-2 (upgradient well) indicated levels of Cu and Zn at lower concentrations than the previous sampling event. Sample analyses showed no VOCs, and all results were below the EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were not detected in well BSB-A1 (north well). All results from this well were also below the EPA's Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were observed at well BSB-A5 (northeast well). Vinyl Chloride was detected above the maximum baseline and background concentrations, while levels of cis-1,2-Dichloroethene were detected above the maximum background concentrations.

Well BSB-A5 showed levels of specific conductance and sulfate above the maximum background concentrations, and levels of chloride above the maximum baseline concentrations.

Sulfate also exceeded the EPA's Maximum Contaminant Level, and Vinyl Chloride exceeded the Montana Human Health Standard.

Six VOCs were detected in well BSB-A6R (central well). From the six VOCs, two (i.e., cis-1,2-Dichloroethene and Vinyl Chloride) exceeded the maximum background concentrations. Vinyl Chloride also exceeded the Montana Human Health Standard.

The sulfate, specific conductance, and chemical oxygen demand results for well BSB-A6R exceeded their corresponding maximum background concentrations and were significantly higher than the results from April 2019. Sulfate was also higher than the EPA's Maximum Contaminant Level.

Well CLK-1 (Clark Tailings east well) had levels of metals (i.e., As, Cd, Co, Fe, Ni, and Zn) detected above the maximum background concentrations, but below the maximum baseline concentrations. Arsenic, Cd, Fe, and Zn were also higher than the EPA's Maximum Contaminant Levels and the Montana Human Health Standards. The levels of sulfate and specific conductance were higher than the maximum background concentrations, with sulfate exceeding the EPA's Maximum Contaminant Level.

The levels of sulfate and specific conductance were above the maximum background concentrations at well CLK-2 (Clark Tailings north well), but below the maximum baseline concentrations. Sulfate also exceeded the EPA's Maximum Contaminant Level.

The results from the September 2019 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6R, CLK-1, and CLK-2 exceeded the EPA's Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years.

9/1/2019

| SAMPLE NUMBER<br>WELL<br>ANALYTE (units): | BSB-GW-01<br>MBMG-2 | | GW-08<br>-1 DUP | BSB-GW-09<br>Field Blank<br>Trip Blank | GW PROTECTION STANDARDS<br>EPA<br>MCL* | <br>MONTANA<br>HHS |
|---|---|---|---|---|---|---|
| **DISSOLVED METALS (mg/L)** | | | | | | |
| Antimony | (Pace 0.00011 J)< 0.0005 | | J)< 0.0005 | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0012 | | **0.15** | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.14 | | 0.026 | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | | 0.0003 | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | | **0.012** | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00038 J)< 0.0005 | | J)< 0.0005 | (Pace 0.00023 J)< 0.0005 | 0.1 | 0.1 |
| Cobalt | 0.00066 | | 0.044 | < 0.0005 | --- | --- |
| Copper | (Pace 0.00093 J)< 0.001 | | 0.0038 | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | | **18.8** | < 0.05 | 0.3(s) | 0.3 |
| Lead | < 0.0001 | | < 0.0001 | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | NR | | NR | NR | 0.002 | 0.002 |
| Nickel | (Pace 0.00035 J)< 0.0005 | | 0.037 | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.001 | | < 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | | NR | NR | 0.1 | 0.1 |
| Thallium | NR | | NR | NR | 0.002 | 0.002 |
| Tin | NR | | NR | NR | | |
| Vanadium | 0.0073 | | J)< 0.001 | < 0.001 | --- | --- |
| Zinc | 0.0084 | | **54.0** | (Pace 0.004 J)< 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | |
| Chloride | 71.5 | | 32.1 | (Pace 0.9 J)< 2 | 250 | --- |
| Chemical Oxygen Demand | < 50 | | NR | NR | --- | --- |
| Specific Conductance (umhos/cm) | 816 | | 1760 | 2.1 | --- | --- |
| Cyanide | < 0.02 | (Pace 0.( | NR | NR | --- | 0.2 |
| Nitrate\Nitrite - N | 5.0 | | NR | NR | 10 | 10 |
| pH | 6.7 | | 5.9 | 6.4 | | |
| Sulfate | 133 | | **5010** | (Pace 0.67 J)< 2.5 | 250 | --- |
| Sulfide | NR | | NR | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | |
| Acetone | < 20 | | SA | < 20 | --- | --- |
| Benzene | < 1 | | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | | SA | < 1 | --- | --- |
| Chloroethane | < 1 | | SA | < 1 | --- | --- |
| Chloroform | < 4 | | SA | 29.4 | --- | 70 |
| Chloromethane | < 4 | | SA | < 4 | --- | --- |
| 1,4-Dichlorobenzene | < 1 | | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | | SA | < 1 | --- | 1000 |
| 1,1-Dichloroethane | < 1 | | SA | < 1 | --- | --- |
| 1,2-Dichloroethane | < 1 | | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | | SA | < 1 | | |
| 1,2-Dichloropropane | < 4 | | SA | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | | SA | NR | --- | --- |
| Methylene Chloride | < 4 | | SA | < 4 | 5 | 30 |
| Naphthalene | NR | | SA | NR | --- | 100 |
| Tetrachloroethene | < 1 | | SA | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | | SA | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | | SA | NR | --- | --- |
| Vinyl Chloride | < 0.2 | | SA | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | | SA | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | |
| Picloram | SA | | SA | SA | | |
| Dicamba | SA | | SA | SA | | |
| 2,4,5-TP (Silvex) | SA | | SA | SA | | |
| 2,4-D | SA | | SA | SA | | |
| **EPA METHOD 8081 (µg/L)** | SA | | SA | SA | | |
| **EPA METHOD 8082 (µg/L)** | SA | | SA | SA | | |

KEY:
- * MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
- NA = Not enough sample available for analysis
- NR = Analysis Not Requested
- ND = Analyte Not Detected
- J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
- SA = Sample Not Taken

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 1: ANALYTICAL DATA AND GROUNDWATER PROTECTION STANDARDS
## DATE SAMPLED: September 17 and 18, 2019

9/1/2019

| SAMPLE NUMBER | BSB-GW-01 | BSB-GW-02 | BSB-GW-03 | BSB-GW-04 | BSB-GW-05 | BSB-GW-06 | BSB-GW-07 | BSB-GW-08 | BSB-GW-09 | GW PROTECTION STANDARDS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WELL | MBMG-2 | BSB-A1 | BSB-A5 | BSB-A6R | CLK-1 | CLK-2 | BSB-A6R DUP | CLK-1 DUP | Field Blank | EPA | MONTANA |
| ANALYTE (units): | | | | | | | | | Trip Blank | MCL* | HHS |
| **DISSOLVED METALS (mg/L)** | | | | | | | | | | | |
| Antimony | (Pace 0.00011 J)< 0.0005 | SA | SA | SA | (Pace 0.00013 J)< 0.0005 | (Pace 0.00016 J)< 0.0005 | SA | (Pace 0.00011 J)< 0.0005 | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0012 | SA | SA | SA | **0.12** | 0.0028 | SA | **0.15** | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.14 | SA | SA | SA | 0.026 | 0.013 | SA | 0.026 | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | SA | SA | SA | 0.00034 | < 0.0002 | SA | 0.0003 | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | SA | SA | SA | **0.012** | 0.00016 | SA | **0.012** | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00038 J)< 0.0005 | SA | SA | SA | < 0.0005 | 0.00063 | SA | (Pace 0.00023 J)< 0.0005 | (Pace 0.00023 J)< 0.0005 | 0.1 | 0.1 |
| Cobalt | 0.00066 | SA | SA | SA | 0.044 | (Pace 0.00029 J)< 0.0005 | SA | 0.044 | < 0.0005 | - - - | - - - |
| Copper | (Pace 0.00093 J)< 0.001 | SA | SA | SA | 0.0041 | 0.0029 | SA | 0.0038 | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | SA | SA | SA | **17** | (Pace 0.045 J)< 0.05 | SA | **18.8** | < 0.05 | 0.3(s) | 0.3 |
| Lead | < 0.0001 | SA | SA | SA | (Pace 0.000076 J)< 0.0001 | < 0.0001 | SA | < 0.0001 | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.002 | 0.002 |
| Nickel | (Pace 0.00035 J)< 0.0005 | SA | SA | SA | 0.038 | 0.006 | SA | 0.037 | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.001 | SA | SA | SA | < 0.0005 | (Pace 0.00031 J)< 0.0005 | SA | < 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.1 | 0.1 |
| Thallium | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.002 | 0.002 |
| Tin | NR | SA | SA | SA | NR | NR | SA | NR | NR | | |
| Vanadium | 0.0073 | SA | SA | SA | (Pace 0.00047 J)< 0.001 | 0.0032 | SA | (Pace 0.00051 J)< 0.001 | < 0.001 | - - - | - - - |
| Zinc | 0.0084 | SA | SA | SA | **51.8** | 0.1 | SA | **54.0** | (Pace 0.004 J)< 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | | | | | | |
| Chloride | 71.5 | 19.7 | 68 | 48.3 | 32.8 | 39.2 | SA | 32.1 | (Pace 0.9 J)< 2 | 250 | - - - |
| Chemical Oxygen Demand | < 50 | < 50 | (Pace 47.2 J)< 50 | 605 | NR | NR | SA | NR | NR | - - - | - - - |
| Specific Conductance (umhos/cm) | 816 | 478 | 1340 | 4950 | 1820 | 1220 | SA | 1760 | 2.1 | - - - | - - - |
| Cyanide | < 0.02 | (Pace 0.007 J)< 0.02 | (Pace 0.009 J)< 0.02 | (Pace 0.0154 J)< 0.021 | NR | NR | SA | NR | NR | - - - | 0.2 |
| Nitrate\Nitrite - N | 5.0 | 0.29 | (Pace 0.17 J)< 0.2 | < 0.2 | NR | NR | SA | NR | NR | 10 | 10 |
| pH | 6.7 | 7.0 | 6.4 | 5.2 | 6.4 | 7 | SA | 5.9 | 6.4 | | |
| Sulfate | 133 | 81.6 | **601** | **3540** | **850** | **407** | SA | **5010** | (Pace 0.67 J)< 2.5 | 250 | - - - |
| Sulfide | NR | NR | NR | NR | NR | NR | NR | NR | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | | | | | | |
| Acetone | < 20 | < 20 | < 20 | < 20 | SA | SA | < 20 | SA | < 20 | - - - | - - - |
| Benzene | < 1 | < 1 | (Pace 0.33 J)< 1 | (Pace 0.37 J)< 1 | SA | SA | (Pace 0.38 J)< 1 | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | - - - | - - - |
| Chloroethane | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | - - - | - - - |
| Chloroform | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | 29.4 | - - - | 70 |
| Chloromethane | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | - - - | - - - |
| 1,4-Dichlorobenzene | < 1 | < 1 | < 1 | (Pace 0.52 J)< 1 | SA | SA | (Pace 0.57 J)< 1 | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | < 1 | (Pace 0.65 J)< 1 | SA | SA | (Pace 0.84 J)< 1 | SA | < 1 | - - - | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | (Pace 0.34 J)< 1 | (Pace 0.45 J)< 1 | SA | SA | (Pace 0.5 J)< 1 | SA | < 1 | - - - | - - - |
| 1,2-Dichloroethane | < 1 | < 1 | 1.1 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | < 1 | 4.1 | 1.7 | SA | SA | 1.7 | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | | |
| 1,2-Dichloropropane | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | - - - |
| Methylene Chloride | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | 5 | 30 |
| Naphthalene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | 100 |
| Tetrachloroethene | < 1 | < 1 | (Pace 0.57 J)< 1 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | < 0.4 | 0.96 | < 0.4 | SA | SA | < 0.4 | SA | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | - - - |
| Vinyl Chloride | < 0.2 | < 0.2 | **2.4** | **0.89** | SA | SA | **0.97** | SA | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | SA | SA | SA | SA | SA | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | | | | | | |
| Picloram | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| Dicamba | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4-D | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |

KEY:

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

mg/L = milligram per Liter
µg/L = microgram per Liter
EPA = U.S. Environmental Protection Agency
MCL = Maximum Contaminant Levels
HHS = Montana Human Health Standards

## BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 3: GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
### DATE SAMPLED: September 17 and 18, 2019

| Well ID | Sample # | Depth (ft) | Diameter (ft) | SWL (ft) | TOC Elevation (ft) | Groundwater Elevation (ft) | pH (su) | ORP (mV) | DO (mg/L) | SC (µS/cm) | T (Celsius) | Sample Time | $H_2O$ Volume Required (gal) | $H_2O$ Volume Purged (gal) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MBMG-2 | BSB-GW-01 | 23.20 | 0.17 | 11.39 | 5529.88 | 5518.49 | 7.08 | 110.9 | 2.67 | 920.21 | 9.28 | 10:15 | 5.91 | 12.67 | |
| BSB-A1 | BSB-GW-02 | 57.00 | 0.17 | 33.95 | 5531.50 | 5497.55 | 7.21 | 79.4 | 0.12 | 522.31 | 9.13 | 11:43 | 11.53 | 18.49 | |
| BSB-A5 | BSB-GW-03 | 45.60 | 0.17 | 37.90 | 5524.62 | 5486.72 | 6.38 | 96.0 | 2.71 | 1664.90 | 8.95 | 13:50 | 3.85 | 4.00 | |
| BSB-A6R | BSB-GW-04 | 59.75 | 0.17 | 45.72 | 5554.41 | 5508.69 | 6.03 | 30.7 | 0.32 | 5650.00 | 9.55 | 14:49 | 7.02 | 8.45 | |
| BSB-A6R | BSB-GW-07 | 59.75 | 0.17 | 45.72 | 5554.41 | 5508.69 | 6.03 | 30.7 | 0.32 | 5650.00 | 9.55 | 14:57 | 7.02 | 8.45 | VOC Duplicate |
| CLK-1 | BSB-GW-05 | 19.00 | 0.17 | 2.41 | 5478.73 | 5476.32 | 6.28 | 125.8 | 0.17 | 1768.40 | 12.07 | 10:39 | 8.30 | 9.77 | |
| CLK-2 | BSB-GW-06 | 46.90 | 0.17 | 36.88 | 5511.17 | 5474.29 | 6.81 | 227.2 | 4.41 | 1279.60 | 9.37 | 11:59 | 5.01 | 8.25 | |
| CLK-1 | BSB-GW-08 | 19.00 | 0.17 | 2.41 | 5478.73 | 5476.32 | 6.28 | 125.8 | 0.17 | 1768.40 | 12.07 | 10:50 | 8.30 | 9.77 | Raw and Dissolved Metals Duplicates |
| Blank | BSB-GW-09 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 13:05 | NA | NA | Field Blank |

**KEY:**

| | | | |
|---|---|---|---|
| ft | feet | SC | Specific Conductance |
| SWL | static water level | µS/cm | micro-Siemens per centimeter |
| TOC | top of casing | T | temperature |
| pH | Potential of Hydrogen | $H_2O$ | water |
| su | standard unit | gal | gallons |
| ORP | Oxidation Reduction Potential | NA | measurement not taken |
| mV | millivolts | | |
| DO | Dissolved Oxygen | | |
| mg/L | milligrams per Liter | | |

7/9/19

Collected CL2-GW-04-070919 at 14:30
1-250ml / Filtered / $HNO_3$ / Dissolved Metals
1-250ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD
1-250ml / NaOH / Cyanide
1-1L / Raw / pH, SC, Cl⁻, $SO_4^{-2}$
3-40ml / HCL / VOCs 8260B

14:48 → NF, NH, PO off site

7/10/19 @ 13:38 → PO dropped off 2 coolers with samples at FedEx and sent to Pace.
Tracking #s: 493437305772
493437305809

7/11/19 @ 08:20 → Both coolers delivered to Pace.

Patricia Olson
7/11/19

OLD Landfill Sample
9/17/19 Smartroll meter
Calibration of meters
0800
pH 4 - 4.02 slope ~~offset~~ -55.81 mV/
7 - 7.01 offset -3.4 mV
10 - 10.02
ORP - 400 - 406.7
offset 19.5 mV
Conductivity 1413 - 1415 -Live
K-cell - 1.008 @ 25.0°C
DO - sat 99.83% Live - 7.38 mg/L
Cal Report 7.18 mg/L 828.22 mbar
Turb 10 - 9.51 20 - 19.5
100 - 99.6 800 - 810
Sampling wells on site @ 0930
Personnel: Nate F, Nate H.
Weather cloudy 52F calm
Safety Rain, mud, slippery

MBMG-2 @ 0930
TD-23.20 DTW = 11.39
0945 begin purging @ 2L/m
Field parameters on FDS
~~5.405~~ 12.672 gallons purged
5 stage pump

9/17/19
Collected **BSB-GW-01** @ 1015
1-250mL / $H_2SO_4$ / $NO_2$ - $NO_3$ / COD
1-1L Raw / pH / SC / CL / $SO_4$
1-250mL / NaOH / Cyanide
1-250mL Filtered $HNO_3$ Diss Metals.
3-40mL / HCL / VOC
offsite @ 1020
TD = ~~26.20~~ 57 nf DTW = ~~11.34~~ 33.95
**BSB-A1** arrived @ ~~1006~~ 1020
1102 begin purging set up Decon and Deconned.
18.49 gallons purged
Field parameters on FDS 5 Stage pump
Stopped purging @ 1140 1 L/m
Collected **BSB-GW-02** @ 1143
1-250mL / $H_2SO_4$ / $NO_2$ - $NO_3$ / COD
1-1L Raw / pH / SC / CL / $SO_4^-$
1-250mL / NaOH / Cyanide NF
~~1-250mL Filtered $HNO_3$ Diss Metals~~
3-40mL / HCL / VOC
offsite @ 1215 After deconning
**BSB-A5** arrived @ 1300
Begin purging with Bailer @ 1315
Took Readings @ 1323
Parameters on FDS / purged 4.0 gal
TD = 45.60 DTW = 32.90

9/17/19
Collected **BSB-GW-03** @ 1350
1-250mL / $H_2SO_4$ / $NO_2$ - $NO_3$ / COD
1-1L Raw / pH / SC / CL / $SO_4^-$
1-250mL / NaOH / Cyanide NF
~~1-250mL / Filtered $HNO_3$ Diss Metals~~
3-40mL / HCL / VOC
offsite @ 1400

**BSB-A6-R** Arrived @ 1410
1433 begin purging 5 stage pump
Purged 8.448 gal Dupe @ 1457
Collected **BSB-GW-04** @ 1449
BSB-GW-07 Dupe time 1457
1-250mL / $H_2SO_4$ / $NO_2$ - $NO_3$ / COD
1-1L Raw / pH / SC / CL / $SO_4^-$
1-250mL / NaOH / Cyanide
~~1-250mL Filtered $HNO_3$ Diss metals.~~ NF
6-40mL / HCL / VOC
offsite @ 1520
**CLK-2** arrived @ 1534
Pump was dirty Attempted Decon but pump Broke, talked with Patty, Heather, & Julie about a pump to use. Julie said to take 2 stage out tomorrow. offsite @ 1600

Rite in the Rain

9/18/19 OLD Landfill
Nate F, Nate H – Pioneer
Weather – partly cloudy calm
45°F

P.H. Smartroll slope
10 – 10.06 ~~Offset~~ -55.27 mv/pH
7 – 7.02 offset = 5.1 mV
4 – ~~4.08~~ 4.06

Cond Kcell – .894
1413 – ~~1385.9~~ 1410.0

ORP ~ 400 – 404.9
Offset -27.4 mV
DO – Live – 7.49 mg/L
Cal Report – 831.23 mbarr 7.33 mg/L
100.55 % Sat
Safety: working close to Road.
Someone was parked at CLK-2.
So we went to CLK-1 first.

CLK-1 Arrived @ 0912
Begin purging @ 0925 TD = 19.06
gallons purged 9.768 DTW = 2.41
Field parameters on FDS
Stopped purging @ 1039
2 stage pump used

---

9/18/19
Collected BSD-GW-05 @ 1039
BSD-GW-08 @ 1050
2-250 mL $HNO_3$ Filt Diss Metals.
2-1L – Raw/pH/SC/CL/$SO_4$
offsite @ 1100

CLK-2 Arrived @ 1120
Begin purging @ 1134 2 stage pum
gallons purged 8.25 TD = 46.90
Field parameters on FDS DTW = 36.
Stopped purging @ 1159
Collected BSB-GW-06 @ 1159
1-250 mL $HNO_3$ Filt Diss Metals
1-1L Raw/pH/SC/CL/$SO_4$
offsite @ 1220

Deconned with additional tub tap + Liquinox.

Collected BSB-GW-09 by pouring DI directly into bottles.
@ 1305
1-250mL/$HNO_3$/Diss Metals
3-40mL HCL/VOC's
2-500mL Raw/pH, SC, Cl, $SO_4^{-2}$

Rite in the Rain

9/18/19 Nate F Dropped
samples off @ 1450
Packeged samples @ 1400
Tracking # 4934 3733 2993
Tracking # 4934 3732 9460
Dropped package off at
FedEx

## FIELD SAMPLE DATA SHEET

Page 0 of 1

PROJECT NAME: Old Landfil

WELL/STATION: MBM6-2 DATE: 9/17/19 TIME: 0930

SAMPLERS: Nate F, Nate H WEATHER CONDITIONS: Cloudy 52

PHOTO: YES ____ NO x NUMBER: N/A

---

## PURGE DATA:

WELL DEPTH: 23.20 FEET

DEPTH TO WATER: 11.39 FEET

COLUMN DEPTH: 11.81 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 20 FEET

3 WELL VOLUMES: 5.905 GALLONS

TOTAL PURGE VOLUME: 12.672 GALLONS

PURGE METHOD: 5 Stage

START PURGING: 0945

PURGE RATE: 2L/m GPM .528 gpm

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 1015

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-01 | 1-250mL | ✓ | $HNO_3$ | Diss Metals |
| 11 | 1-1L | | Raw | pH/SC/Cl/$SO_4^{-2}$ |
| 11 | 1-250mL | | $H_2SO_4$ | $NO_2$/$NO_3$/COD |
| 11 | 1-250mL | | NaOH | Cyanide |
| 11 | 3-40mL | | HCL | 82606 |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED (g) | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 0951 | 3.1686 | 9.26 | 6.65 | 919.50 | 212.4 | 2.90 |
| 0954 | 4.728 | 9.15 | 6.88 | 919.64 | 153.4 | 2.82 |
| 0957 | 6.288 | 9.18 | 6.97 | 924.44 | 137 | 2.76 |
| 1000 | 7.848 | 9.23 | 7.01 | 922.25 | 128.8 | 2.73 |
| 1003 | 9.408 | 9.25 | 7.04 | 923.25 | 120.3 | 2.70 |
| 1006 | 10.968 | 9.25 | 7.08 | 920.72 | 110.2 | 2.68 |
| 1009 | 12.552 | 9.28 | 7.08 | 920.21 | 110.9 | 2.67 |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1009 | 12.552 | 9.28 | 7.08 | 920.21 | 110.9 | 2.67 |

FIELD REMARKS: IDO = 11.28

PIONEER TECHNICAL SERVICES, INC.

# FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Old Landfill

WELL/STATION: BSB-A1 DATE: 9/17/19 TIME: 1106

SAMPLERS: NF / NH WEATHER CONDITIONS: Rain Cloudy / calm 52F

PHOTO: YES ______ NO X NUMBER: N/A

---

## PURGE DATA:

PURGE METHOD: 5 stage

START PURGING: 1107

PURGE RATE: 1L/m GPM

RATE CHANGE: 1) TIME: 1109 RATE: 2L/m 1.79

2) TIME: ______ RATE: ______

SAMPLE TIME: 1143

WELL DEPTH: 57 FEET

DEPTH TO WATER: 33.95 FEET

COLUMN DEPTH: 23.05 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 55 FEET

3 WELL VOLUMES: 11.525 GALLONS

TOTAL PURGE VOLUME: 18.49 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-02 | 1-1L | Raw | | PH, SS, Cl, $SO_4^{-2}$ |
| 11 | 1-250mL | $H_2SO_4$ | | $NO_2$ $NO_3$ COD |
| 11 | 1-250mL | NaOH | | Cyanide |
| 11 | 3-40mL | HCL | | 8260B |
| 11 | | | | |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1130 | 44L | 8.48 | 7.23 | 522.29 | 47.4 | .23 |
| 1133 | 50L | 9.04 | 7.20 | 518.00 | 75.3 | .25 |
| 1136 | 56L | 9.04 | 7.21 | 520.58 | 78.9 | .18 |
| 1139 | 62L | 9.13 | 7.21 | 522.31 | 79.4 | .12 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1139 | 62L | 9.13 | 7.21 | 522.31 | 79.4 | .12 |

DT

L/C

42.

FIELD REMARKS: ______

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: GLD Landfill

WELL/STATION: BSB-A5 DATE: 9/19/19 TIME: 1300

SAMPLERS: NE/NH WEATHER CONDITIONS: Cloudy Rain

PHOTO: YES ____ NO X NUMBER: N/A

---

## PURGE DATA:

PURGE METHOD: Bailer

START PURGING: 1315

PURGE RATE: ____ GPM

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 1350

WELL DEPTH: 45.60 FEET

DEPTH TO WATER: 37.90 FEET

COLUMN DEPTH: 7.7 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: — FEET

3 WELL VOLUMES: 3.85 GALLONS

TOTAL PURGE VOLUME: 4.0 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-03 | 1-250mL | | $H_2SO_4$ | $NO_2$-$NO_3$ COD |
| " | 1-250mL | | NaOH | Cyanide |
| " | NA ~~250mL~~ | | | |
| " | 3-40mL | | HCL | VOC 8260B |
| " | 1-1L | | Raw | pH, SC, CL, $SO_4^{2-}$ |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| | | 9. | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1323 | 1.5 | 8.95 | 6.38 | 1664.9 | 96.0 | 2.77 |

FIELD REMARKS: ____

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB old Landfill
WELL/STATION: BSD-A8-R DATE: 9/12/19 TIME: 1410
SAMPLERS: NF/NH WEATHER CONDITIONS: Rain/52F/ cloudy
PHOTO: YES ____ NO X NUMBER: NA

---

## PURGE DATA:

PURGE METHOD: 5 Stage
START PURGING: 1433
PURGE RATE: 2L/m GPM .528 gpm
RATE CHANGE: 1) TIME: ____ RATE: ____
2) TIME: ____ RATE: ____
SAMPLE TIME: 1449 Dupe 1457

WELL DEPTH: 59.75 ~~45.72~~ FEET
DEPTH TO WATER: 45.72 FEET
COLUMN DEPTH: 14.03 FEET
CASING DIAMETER: 2 INCH
PUMP SET AT: 58 FEET
3 WELL VOLUMES: 7.015 GALLONS
TOTAL PURGE VOLUME: 8.448 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-04 | 1-250mL | H2SO4 | | $NO_2$-$NO_3$ COD |
| " | 1-250mL | NaOH | | cyanide |
| " | 3-40mL | HCL | | voc 8260b |
| " | 1-1L | Raw | | pH/SC Cl/SO4 |
| BSB-GW-07 | 3-40mL | HCL | | VOC 8260b |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1436 | 1.54 Gal | 9.75 | 6.03 | 5582.6 | 48.4 | 1.04 |
| 1439 | 3.168 | 9.84 | 6.04 | 5613.5 | 43.0 | 0.75 |
| 1442 | 4.752 | 9.92 | 6.04 | 5686.4 | 37.6 | 0.50 |
| 1445 | 6.336 | 10.03 | 6.04 | 5724.4 | 34.2 | 0.43 |
| 1448 | 7.92 | 9.55 | 6.03 | 5650.0 | 30.7 | 0.32 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1448 | 7.92 | 9.55 | 6.03 | 5650.0 | 30.7 | 0.32 |

48.3

FIELD REMARKS: BSB-6W-07 is Dup of this well.

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Jld Landfill
WELL/STATION: C/K-1 DATE: 9/18/19 TIME: 0912
SAMPLERS: NE/NH WEATHER CONDITIONS: clear calm 50
PHOTO: YES ____ NO X NUMBER: NA

### PURGE DATA:

PURGE METHOD: 2 Stage
START PURGING: 0925
PURGE RATE: .5 L/m GPM ,132 g/m
RATE CHANGE: 1) TIME: ____ RATE: ____
2) TIME: ____ RATE: ____
SAMPLE TIME: 1039 Dupe @ 1050

WELL DEPTH: 19.00 FEET
DEPTH TO WATER: 2.41 FEET
COLUMN DEPTH: 16.59 FEET
CASING DIAMETER: 2 INCH
PUMP SET AT: 15 FEET
3 WELL VOLUMES: 8.3 GALLONS
TOTAL PURGE VOLUME: 9.768 GALLONS

16
57 mins
782
.864

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-05 | 1-250ml | ✓ | $HNO_3$ | Diss Metals |
| BSB-GW-05 | 1-1L | | Raw | pH/SC/CL$^-$/$SO_4^-$ |
| BSB-GW-08 | 1-250ml | ✓ | $HNO_3$ | Diss ~~AA~~ Metals NE |
| BSB-GW-08 | 1-1L | | Raw | pH/SC/CL$^-$/$SO_4^-$ |
| | | | | |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1018 | 6.996 | 11.89 | 6.27 | 1764.3 | 112.4 | .20 |
| 1021 | 7.392 | 11.89 | 6.27 | 1768.4 | 115.0 | .19 |
| 1024 | 7.788 | 11.95 | 6.28 | 1775.6 | 118.9 | .18 |
| 1027 | 8.184 | 11.98 | 6.28 | 1771.2 | 120.6 | .18 |
| 1030 | 8.58 | 12.05 | 6.28 | 1767.7 | 124.5 | .17 |
| 1033 | 8.976 | 12.07 | 6.28 | 1768.4 | 125.8 | .17 |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 1033 | 8.976 | 12.07 | 6.28 | 1768.4 | 125.8 | .17 |

FIELD REMARKS: BSB-GW-08 Dupe of this well

**PIONEER TECHNICAL SERVICES, INC.**

# FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB old Land Fill

WELL/STATION: C/K-2 DATE: 9/18/19 TIME: ~~1534~~ 1120

SAMPLERS: NF/NH WEATHER CONDITIONS: Clear calm 59F

PHOTO: YES ____ NO X NUMBER: N/A

---

## PURGE DATA:

PURGE METHOD: ~~3~~ 2 stage

START PURGING: 1134

PURGE RATE: 1.25L GPM .33 g/m

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 1159 ~~Dupl~~

WELL DEPTH: 46.90 FEET

DEPTH TO WATER: 36.88 FEET

COLUMN DEPTH: ~~9.44~~ 10.02 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 45 FEET

3 WELL VOLUMES: ~~4.995~~ 5.01 GALLONS

TOTAL PURGE VOLUME: 8.25 GALLONS

---

## SAMPLE DATA:

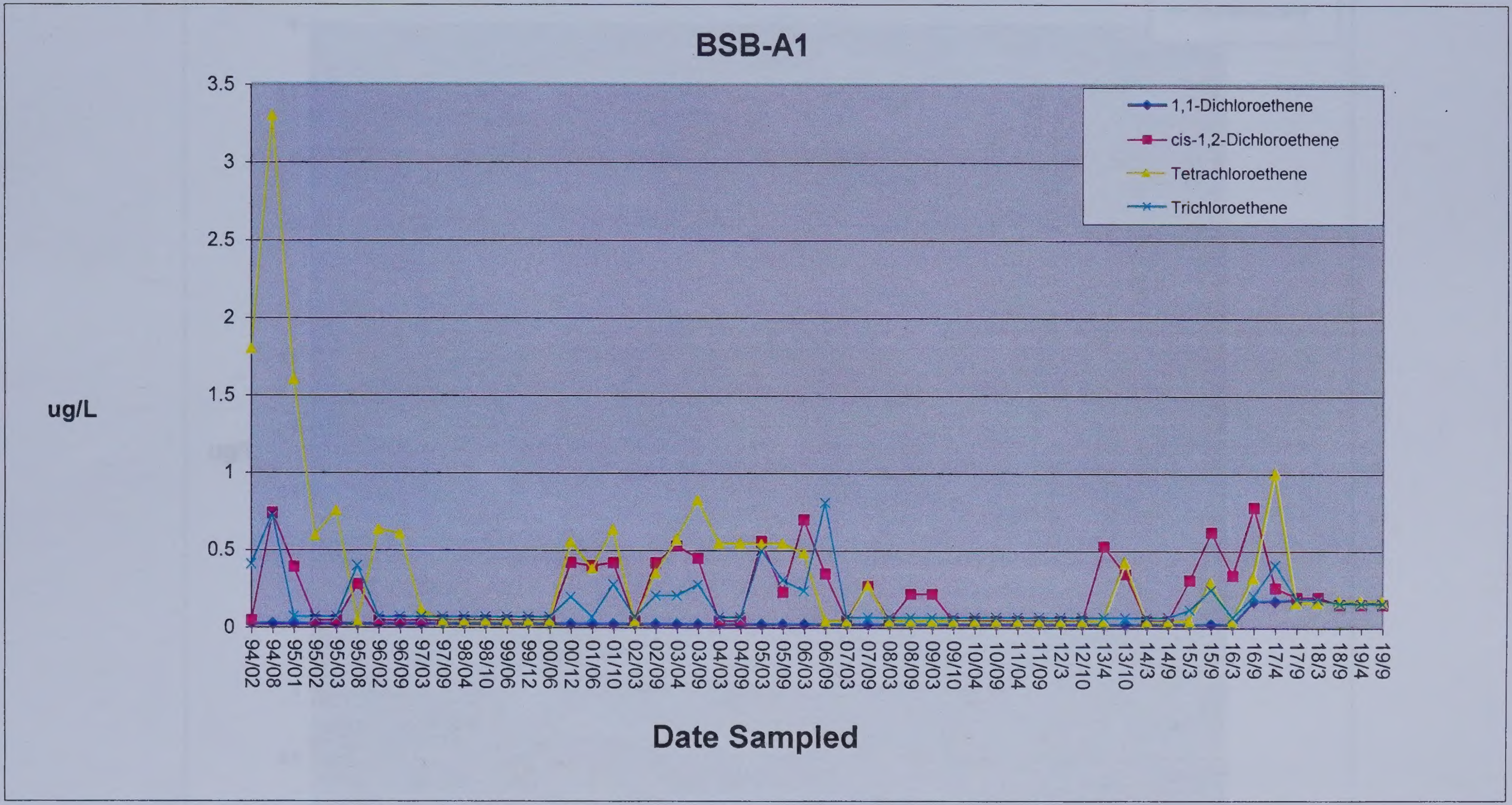
| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-06 | 1-250mL | ✓ | HNO3 | Diss Metals |
| BSB-GW-06 | 1-L | | Raw | PH/SC/Cl/SO4-2 |
| | | | | |
| | | | | |
| | | | | |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1140 | 1.98 | 9.70 | 6.55 | 1285.5 | 261.2 | 1.87 |
| 1143 | 2.97 | 9.57 | 6.61 | 1272.6 | 211.2 | 2.97 |
| 1146 | 3.96 | 9.42 | 6.72 | 1274.7 | 210.2 | 3.88 |
| 1149 | 4.95 | 9.41 | 6.76 | 1275.6 | 218.7 | 4.17 |
| 1152 | 5.94 | 9.37 | 6.79 | 1278.1 | 224.3 | 4.36 |
| 1155 | 6.93 | 9.37 | 6.81 | 1279.6 | 222.2 | 4.41 |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 11.55 | 6.93 | 9.37 | 6.81 | 1279.6 | 227.2 | 4.41 |

FIELD REMARKS: ____

PIONEER TECHNICAL SERVICES, INC.


BSB-A1
ug/L
3.5
3
2.5
2
1.5
1
0.5
0
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
97/09
98/04
98/10
99/06
99/12
00/06
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13/4
13/10
14/3
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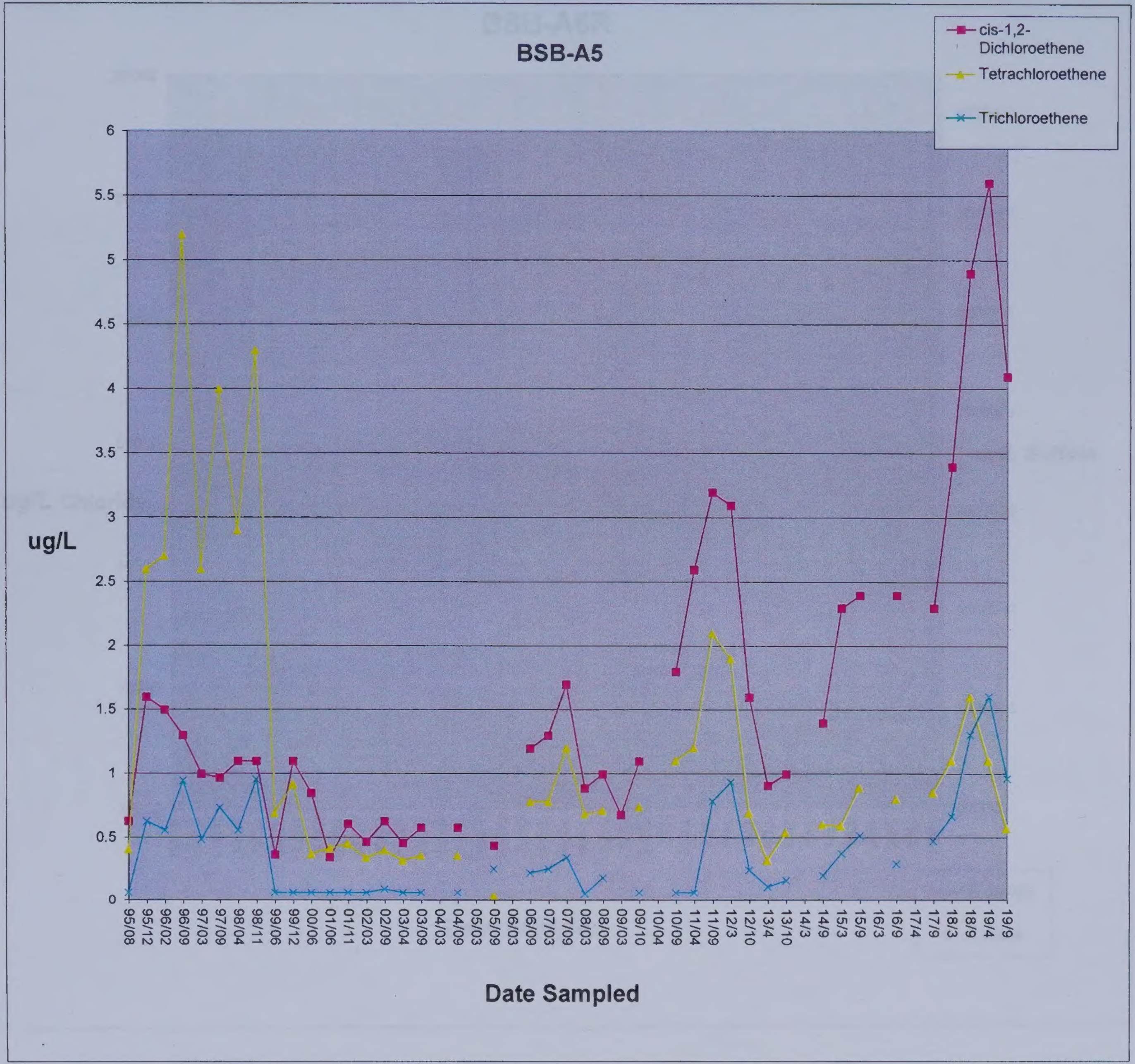
18/9
19/4
19/9
Date Sampled


BSB-A5
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
ug/L
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
95/08
95/12
96/02
96/09
97/03
97/09
98/04
98/11
99/06
99/12
00/06
01/06
01/11
02/03
02/09
03/04
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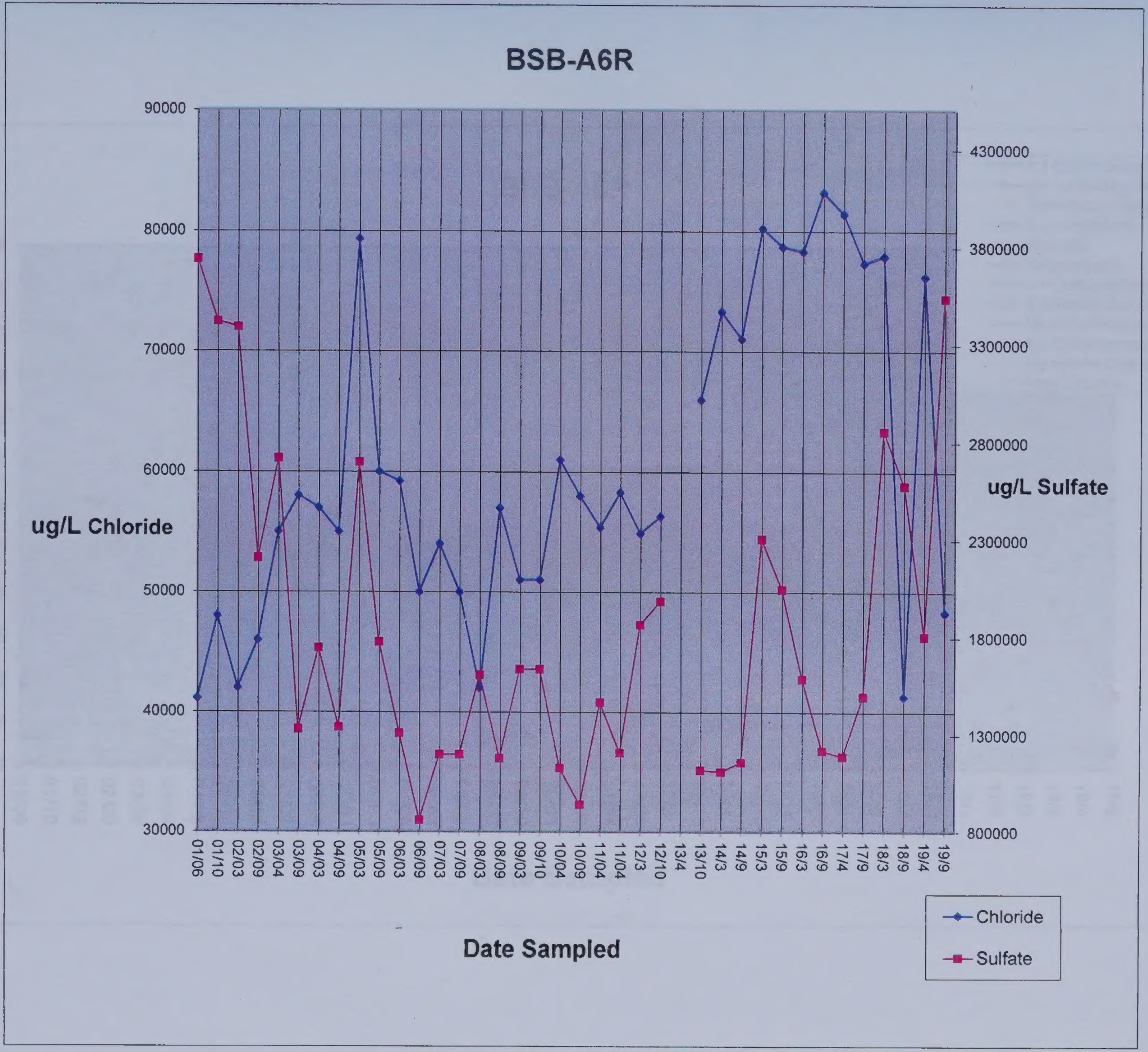
18/9
19/4
19/9
Date Sampled



BSB-A6R

90000
80000
70000
60000
50000
40000
30000
ug/L Chloride
4300000
3800000
3300000
2800000
2300000
1800000
1300000
800000
ug/L Sulfate
01/06
01/10
02/03
02/09
03/04
03/09
04/03
04/09
05/03
05/09
06/03
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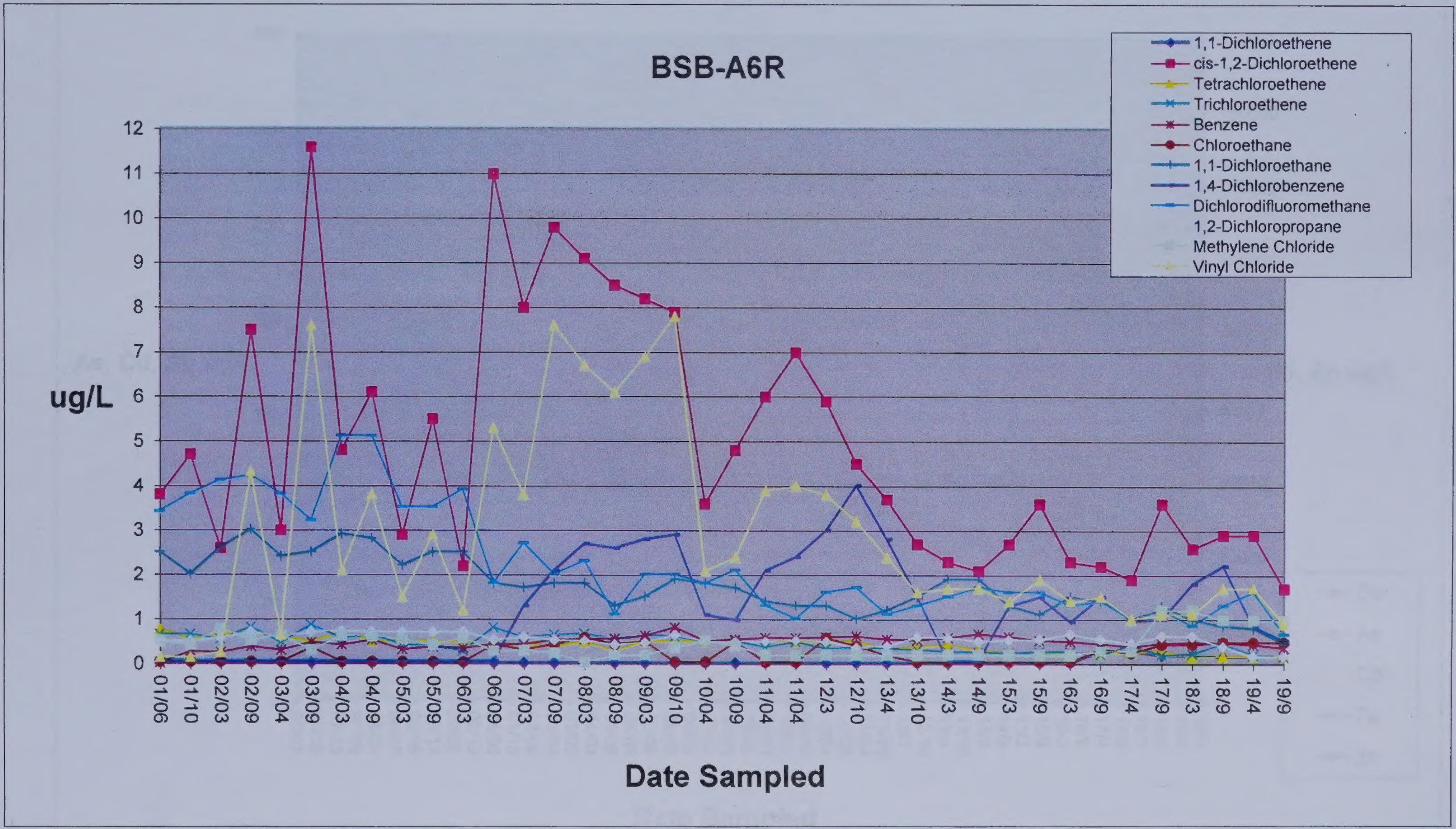
Date Sampled
Chloride
Sulfate


BSB-A6R
ug/L
12
11
10
9
8
7
6
5
4
3
2
1
0
01/06
01/10
02/03
02/09
03/04
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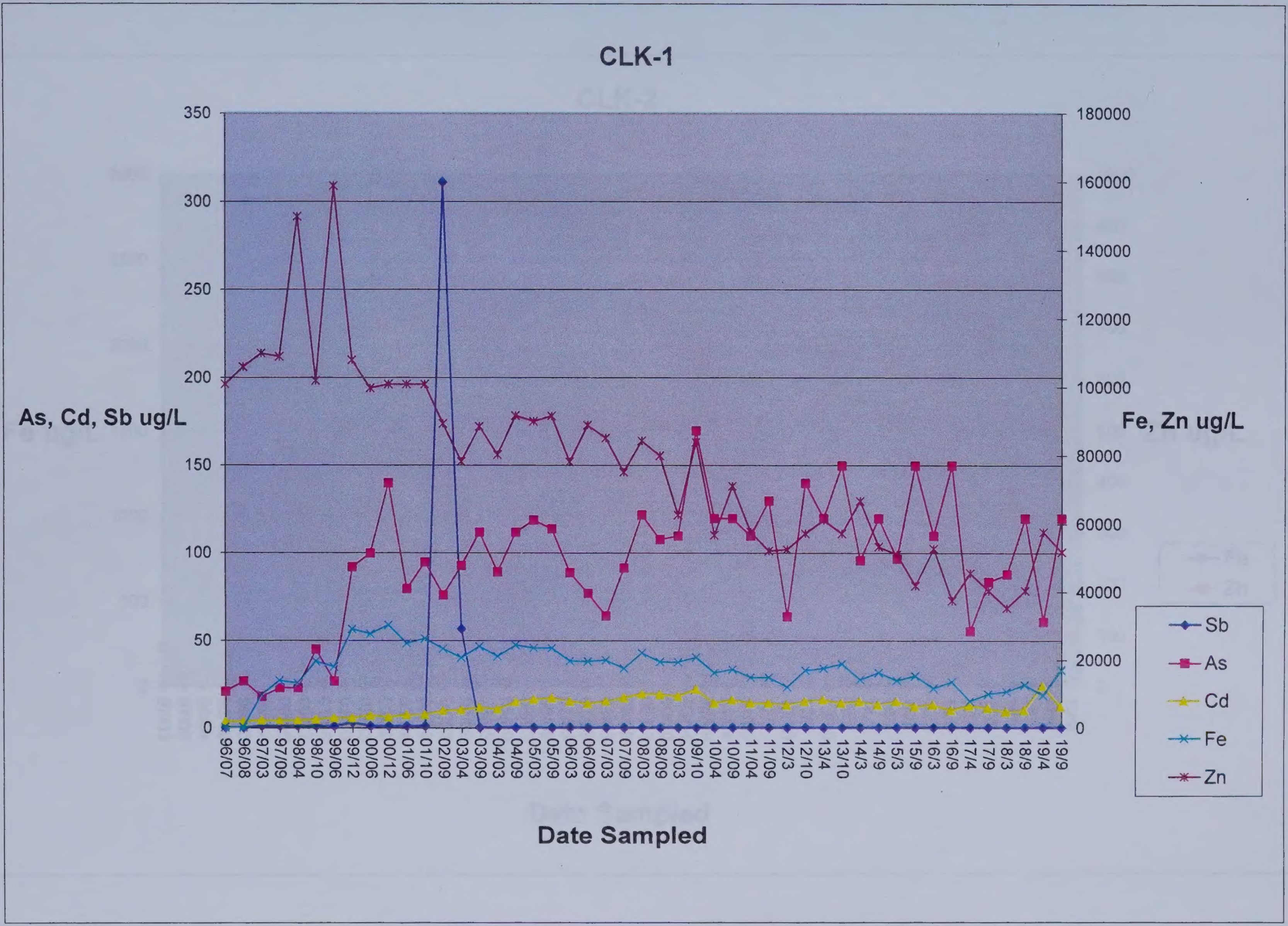
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
18/3
18/9
19/4
19/9
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride


CLK-1
As, Cd, Sb ug/L
0
50
100
150
200
250
300
350
Fe, Zn ug/L
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
00/06
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14/3
14/9
15/3
15/9
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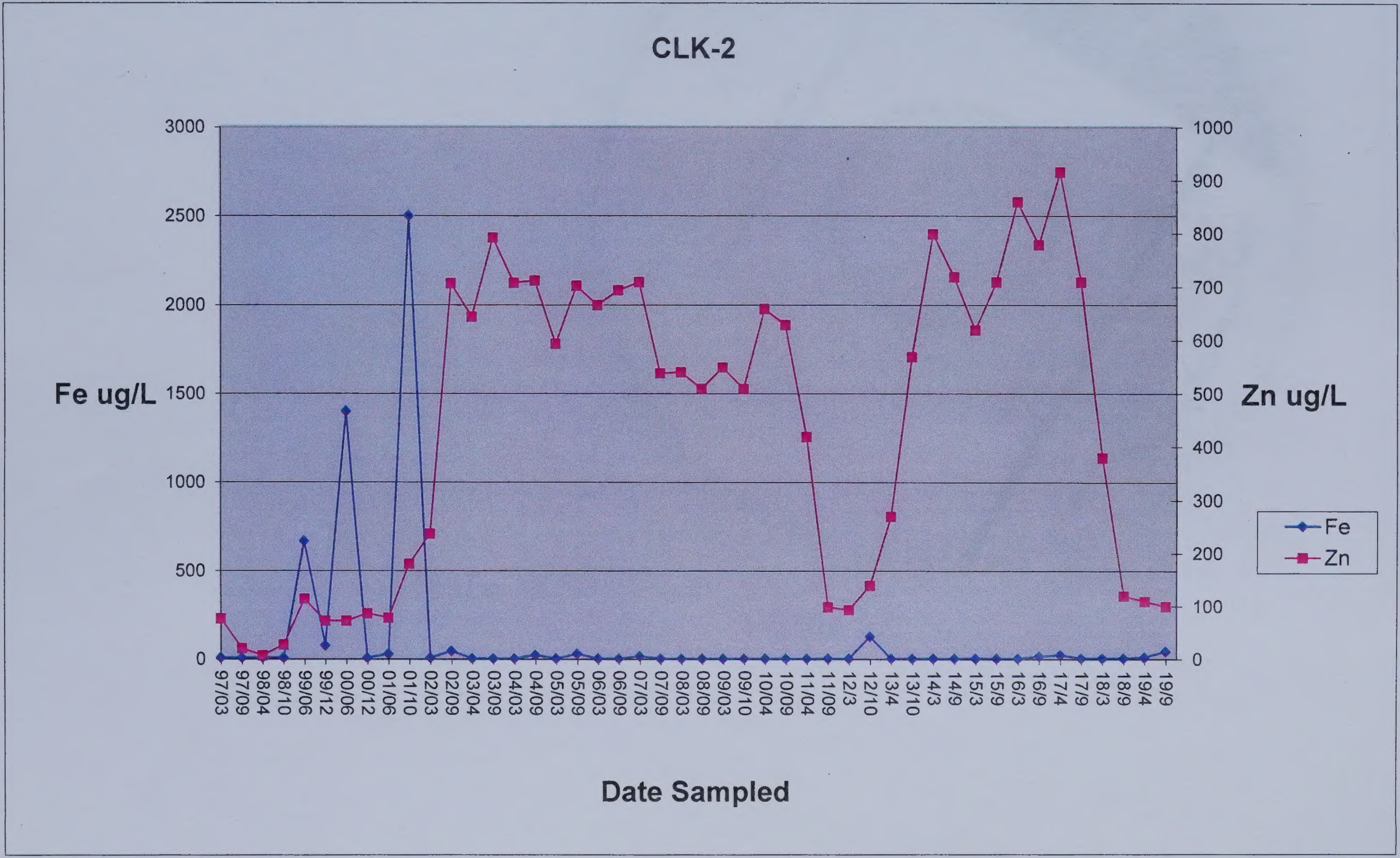
19/9
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
Fe ug/L
Zn ug/L
3000
2500
2000
1500
1000
500
0
1000
900
800
700
600
500
400
300
200
100
0
Fe
Zn
97/03
97/09
98/04
98/10
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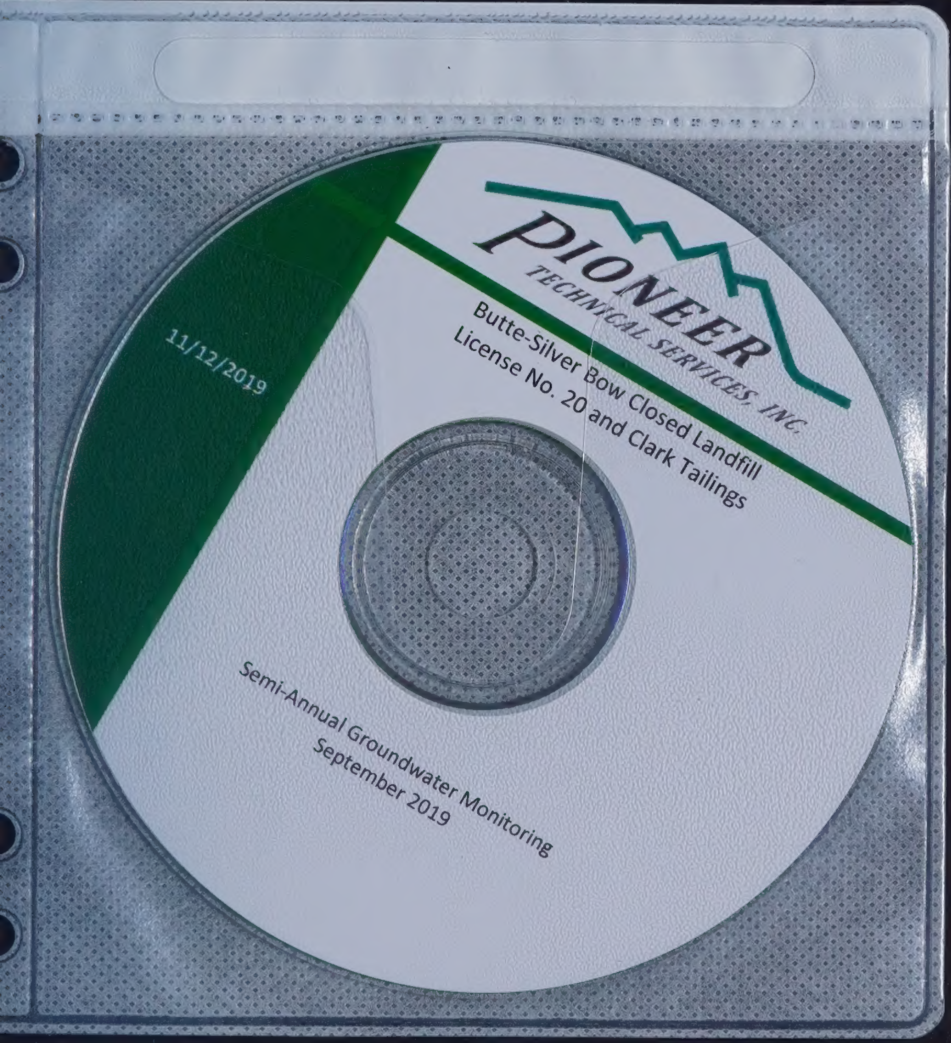
Date Sampled



PIONEER TECHNICAL SERVICES, INC

Butte-Silver Bow Closed Landfill
License No. 20 and Clark Tailings

11/12/2019

Semi-Annual Groundwater Monitoring
September 2019

PIONEER
TECHNICAL SERVICES, INC.

County Silver-Bow
Facility & # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run-on

December 10, 2018

Mr. John Collins
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear John:

On September 20 and 21, 2018, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring for the Butte-Silver Bow (BSB) Closed Landfill and the Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from four monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

- A figure showing the location of the groundwater monitoring wells (Figure 1).
- The Groundwater Potentiometric Surface Map for September 2018 (Figure 2).
- A document comparing the September 2018 results to previous results, maximum baseline and background concentrations, and groundwater protection standards (Attachment 1).
- A table comparing the September 2018 analytical data to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards (Table 1).
- A table showing the groundwater monitoring data and a non-parametric comparison of the monitoring wells (Table 2) (included electronically with this letter).
- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- Copy of field notes and field sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2.

PIONEER
TECHNICAL SERVICES, INC.

December 10, 2018

RECEIVED

DEC 13 2018

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Mr. John Collins
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear John:

On September 20 and 21, 2018, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring for the Butte-Silver Bow (BSB) Closed Landfill and the Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from four monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

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HEADQUARTERS: PO BOX 3445 • BUTTE, MT 59702 | PH: 406.782.5177 • FX: 406.782.5866 | WWW.PIONEER-TECHNICAL.COM

ANACONDA • BILLINGS • BOZEMAN • HELENA • MISSOULA • EVANSTON, WY • KELLOGG, ID

The following sections provide a summary of the groundwater velocity calculations and statistical analysis conducted by Pioneer for the BSB Closed Landfill and the Clark Tailings site.

## Groundwater Velocity Calculations

Using the depth-to-groundwater measurements collected during the September 2018 monitoring event, a groundwater potentiometric surface map was developed (Figure 2). Based on Figure 2, groundwater flows in a northern direction at a hydraulic gradient ranging from 1.83E-02 feet per foot (ft/ft) to 2.62E-02 ft/ft. This is consistent with the past groundwater flow direction and range of hydraulic gradients. Using the hydraulic gradients, two groundwater velocities were calculated using both Darcy's Law and the equation for the seepage velocity. The average groundwater velocity for the September 2018 sampling event was 0.21 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the average groundwater velocity was acquired from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

## Water Quality Results

The September 2018 sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the EPA Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The September 2018 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well, MBMG-2) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

The results from the September 2018 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6-R, CLK-1, and CLK-2 exceed the EPA Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years.

Please refer to Attachment 1 for a summary and analysis of the September 2018 results.

## Statistical Analysis

Pioneer has calculated a confidence level of 98.1 % per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

If you have any questions or concerns, please contact me at (406) 497-8056.

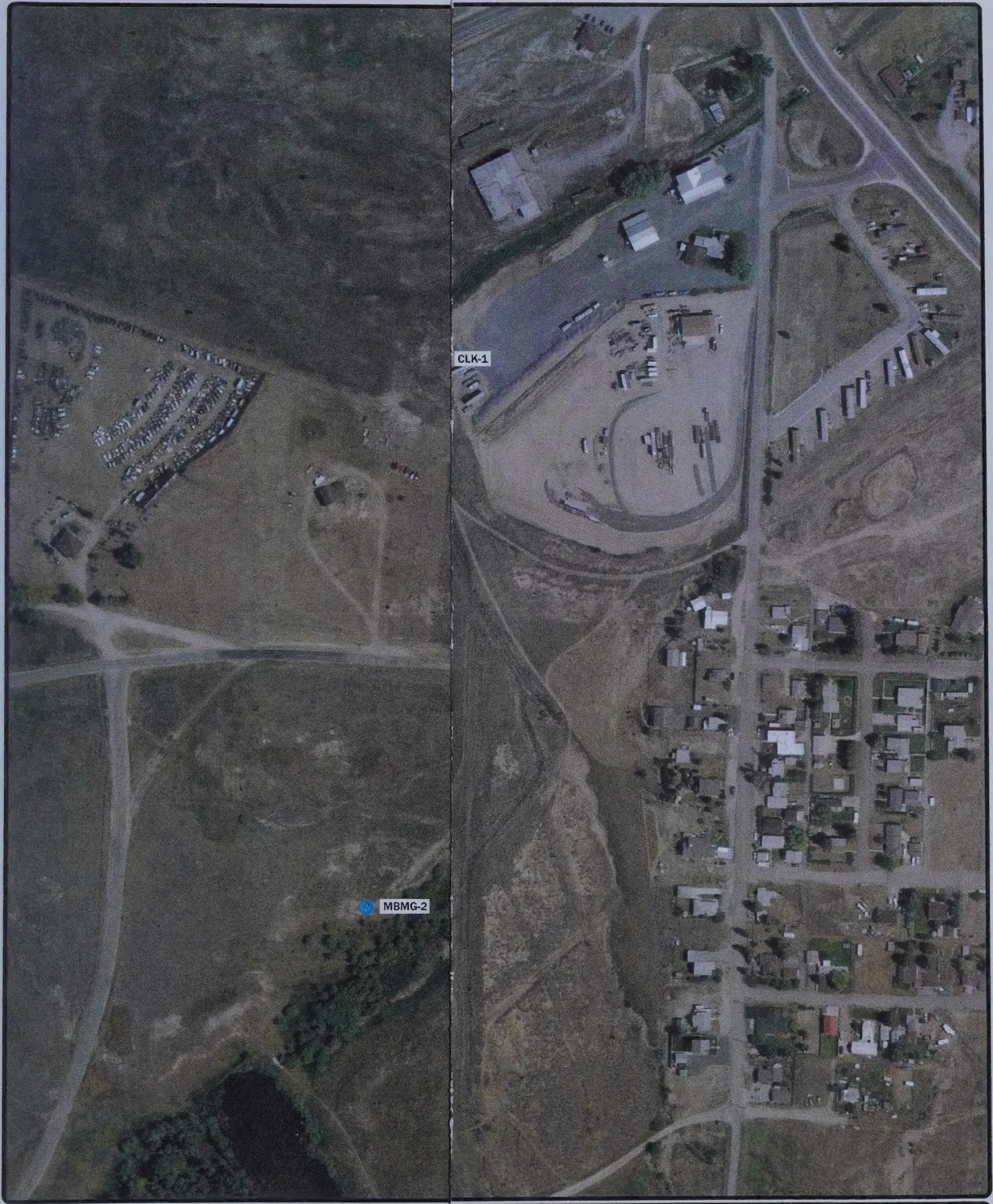
Sincerely,

Patricia Olson

Patty Olson
Staff Engineer

Encl.

cc. Mark Neary, BSB Public Works Director
Glen Rafish, BSB Landfill Manager
Joseph S. McElroy, Pioneer Project Manager (email)
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Josh Bryson, Atlantic Richfield (email)
Loren Burmeister, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com



LEGEND

● GROUNDWATER MONITORING WELLS

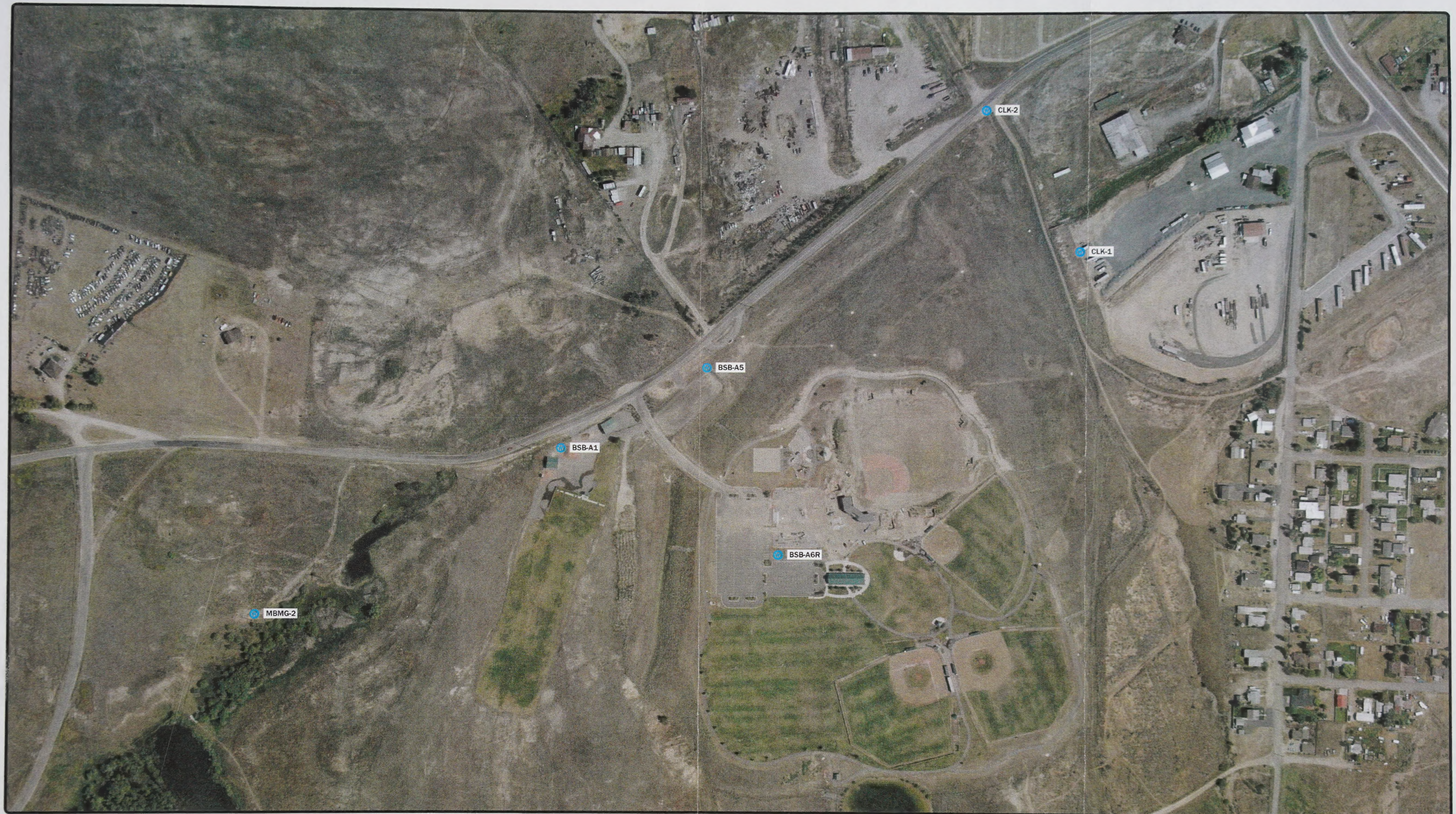
FIGURE 1

BUTTE-SILVER BOW
CLOSED LANDFILL/CLARK
TAILINGS GROUNDWATER
MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - L



LEGEND

● GROUNDWATER MONITORING WELLS

DISPLAYED AS:

COORD SYS/ZONE: MSP83

DATUM: NAVD88

UNITS: IF

SOURCE: PIONEER/AES

SCALE IN FEET

0 100 200

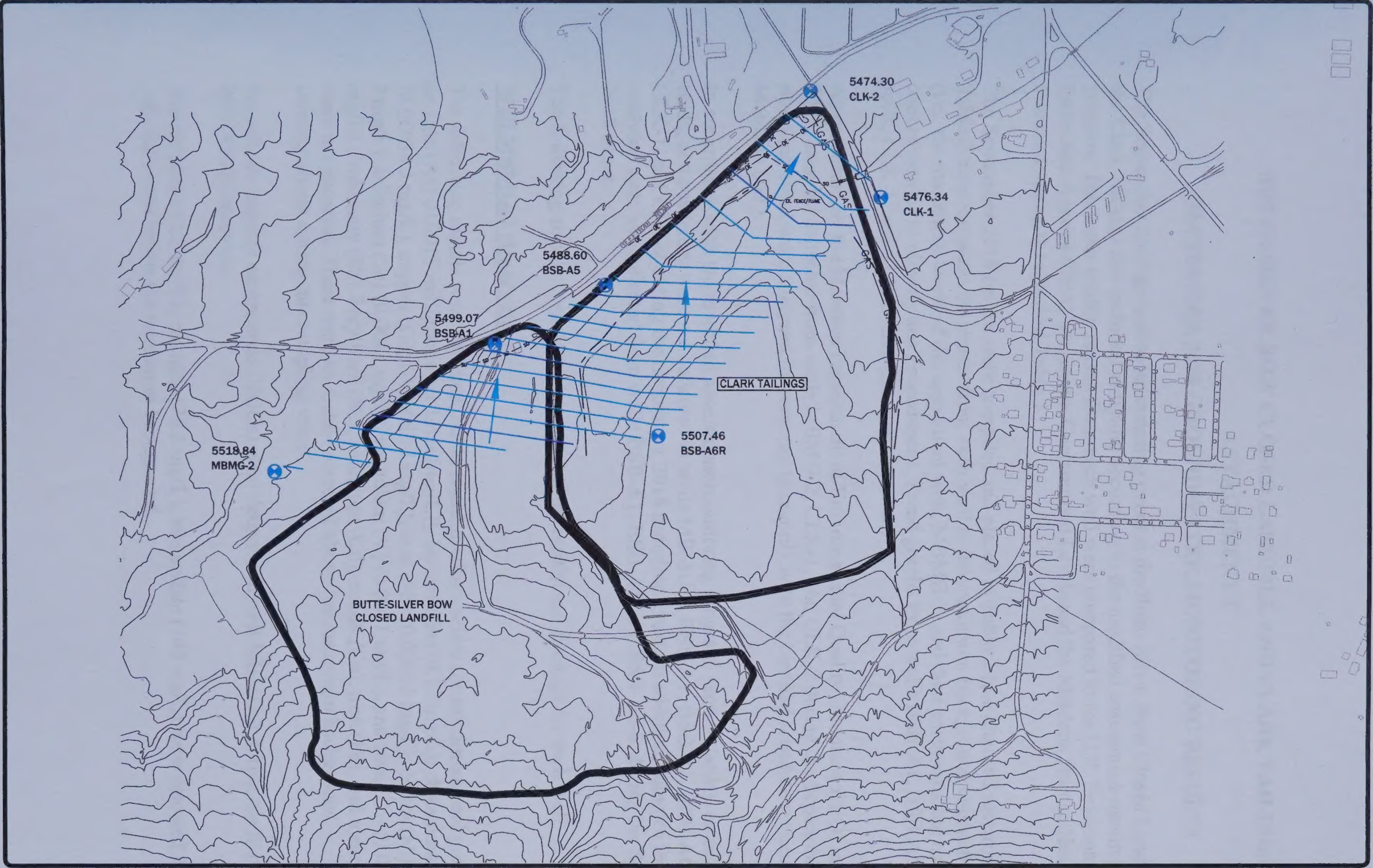
FIGURE 1

# BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-001-18.DWG



5474.30
CLK-2
5476.34
CLK-1
5488.60
BSB-A5
5499.07
BSB-A1
5507.46
BSB-A6R
5518.84
MBMG-2
CLARK TAILINGS
BUTTE-SILVER BOW
CLOSED LANDFILL
GAS
EX. FENCE/FLUME
McKinley Ave
Clay Ave
Calhoun Ave

## LEGEND

CLK-1 ● GROUNDWATER MONITORING WELL

—— CONTOUR

CONTOUR INTERVAL= 10'

| | |
|---|---|
| DISPLAYED AS: | |
| COORD SYS/ZONE: | NA |
| DATUM: | NA |
| UNITS: | FEET |
| SOURCE: | PIONEER |

SCALE IN FEET
0 300 600

FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

# SEPTEMBER 2018 GROUNDWATER POTENTIOMETRIC SURFACE MAP

DATE: 11/2018

11/29/2018 9:40:51 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-003-18.DWG

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS

## ATTACHMENT 1

## SEPTEMBER 2018 GROUNDWATER MONITORING RESULTS

The September 2018 groundwater sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The September 2018 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well, MBMG-2) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

As requested by the Montana Department of Environmental Quality (Montana DEQ) in May 2013, samples collected from wells MBMG-2, CLK-1, and CLK-2 during the September 2018 sampling event were analyzed for mercury to comply with the biennial schedule requested by the Montana DEQ.

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in wells MBMG-2, BSB-A1, BSB-A5, BSB-A6-R, CLK-1, and CLK-2 during the September 2018 sampling event. In addition, samples for metals analyses were not collected from wells BSB-A1, BSB-A5, and BSB-A6-R during the September 2018 event.

The following sections provide a summary of the results and findings for each well.

**Well MBMG-2 (Upgradient):**

The following metals were detected, but at concentrations below the maximum background: arsenic (As) (0.0013 milligrams per Liter [mg/L]), barium (Ba) (0.15 mg/L), chromium (Cr) (0.00034 J mg/L), copper (Cu) (0.00083 J mg/L), lead (Pb) (0.00014 mg/L), nickel (Ni) (0.00023 J mg/L), selenium (Se) (0.0011 mg/L), vanadium (V) (0.0081 mg/L), and zinc (Zn) (0.0036 J mg/L). Antimony (Sb), beryllium (Be), cadmium (Cd), cobalt (Co), iron (Fe), and mercury (Hg) were not detected. There were no metals detected above the maximum background concentrations during this sampling event.

No volatile organic compounds (VOCs) were detected in well MBMG-2 during the September 2018 sampling event.

Nitrate/nitrite (1.6 mg/L), chloride (70.8 mg/L), and sulfate (146 mg/L) were detected, but at concentrations below the maximum background.

Analytical results from well MBMG-2 did not exceed any of the EPA Maximum Contaminant Levels or the Montana Human Health Standards during the September 2018 sampling event.

**Well BSB-A1 (North Well):**

Volatile organic compounds were not detected in well BSB-A1 during the September 2018 sampling event.

The September 2018 results from well BSB-A1 were compared to the EPA Maximum Contaminant Levels and the Montana Human Health Standards and no exceedances were observed.

The results from September 2018 are consistent with the results from March 2018.

**Well BSB-A5 (Northeast Well):**

Levels of cis-1,2-Dichloroethene (4.9 micrograms per Liter [μg/L]), Trichloroethene (1.3 μg/L), and Vinyl Chloride (0.43 μg/L) were detected above the maximum baseline and background concentrations. Levels of Tetrachloroethene (1.6 μg/L) were detected above the maximum background concentration. The following VOCs were also detected, but at concentrations below the maximum baseline and background concentrations: 1,1-Dichloroethane (0.40 J μg/L) and 1,2-Dichloropropane (0.3 J μg/L). The attached trend graph for well BSB-A5 shows that the levels of cis-1,2-Dichloroethene, Tetrachloroethene, and Trichloroethene are continuing to trend upward.

Specific conductance (1,600 micromhos per centimeter [umhos/cm]) and sulfate (606 mg/L) were detected above the maximum background concentrations. Nitrate/nitrite (0.26 mg/L) and chloride (41.7 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations.

Results from the September 2018 sampling event also show that the level of sulfate (606 mg/L) exceeded the EPA Maximum Contaminant Level for this analyte (250 mg/L), and the level of Vinyl Chloride (0.43 μg/L) exceeded the Montana Human Health Standard for this analyte (0.2 μg/L).

**Well BSB-A6-R (Central Well):**

Well BSB-A6-R is the replacement well for BSB-A6, which was removed during construction of the Timber Butte Youth Park.

The following VOCs were detected in well BSB-A6-R during the September 2018 sampling event:

- Benzene (0.48 J μg/L).
- 1,4-Dichlorobenzene (2.2 μg/L) exceeds the maximum background concentration.
- Dichlorodifluoromethane (1.3 μg/L) exceeds the maximum background concentration.

- 1,1-Dichloroethane (0.84 J µg/L).
- cis-1,2-Dichloroethene (2.9 µg/L) exceeds the maximum background concentration.
- 1,2-Dichloropropane (0.4 J µg/L).
- Trichloroethene (0.43 µg/L).
- Vinyl Chloride (1.7 µg/L) exceeds the maximum background concentration.

The attached trend graph for well BSB-A6R indicates that the VOC results are consistent with the results from previous sampling events.

Vinyl chloride (1.7 µg/L) also exceeded the Montana Human Health Standard for this analyte (0.2 µg/L).

Sulfate (2,580 mg/L), specific conductance (3,900 umhos/cm), and chemical oxygen demand (469 mg/L) were detected above the maximum background concentrations. Nitrate/nitrite (0.26 mg/L) and chloride (41.3 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. The attached trend graph for well BSB-A6R show that the levels of chloride (41.3 mg/L) decreased significantly when compared to the March 2018 levels (77.9 mg/L).

Results from the September 2018 sampling event also show that the level of sulfate (2,580 mg/L) exceeded the EPA Maximum Contaminant Level for this analyte (250 mg/L).

**Well CLK-1 (Clark Tailings East Well):**

Metals detected above the maximum background concentrations, but below the maximum baseline concentrations include: As (0.12 mg/L), Cd (0.0099 mg/L), Co (0.036 mg/L), Fe (12.5 mg/L), Ni (0.030 mg/L), and Zn (40.5 mg/L).

Antimony (0.00012 J mg/L), Ba (0.022 mg/L), Be (0.00033 mg/L), Cr (0.0013 mg/L), Cu (0.0019 mg/L), Pb (0.000056 J mg/L), Hg (0.000006 J mg/L), Se (0.00017 J mg/L), and V (0.00028 J mg/L) were detected, but at concentrations below the maximum baseline and background concentrations.

Arsenic, Cd, Fe, and Zn also exceeded the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

The levels of sulfate (626 mg/L) and specific conductance (1,530 umhos/cm) exceeded the maximum background concentrations. Chloride (28.9 mg/L) was detected, but at concentrations below the maximum baseline and background. The level of sulfate (626 mg/L) was also higher than the EPA Maximum Contaminant Level for this analyte (250 mg/L).

The attached trend graph for well CLK-1 indicates that the results are consistent with the results from previous sampling events.

**Well CLK-2 (Clark Tailings North Well):**

Zinc (0.12 mg/L) was detected at well CLK-2 above the maximum background concentration, but below the maximum baseline concentration. The attached trend graph for well CLK-2 also indicates that the levels of Zn decreased significantly when compared to the September 2017 results. For example, Zn levels went from 0.71 mg/L during September 2017 to 0.12 mg/L during September 2018.

Antimony (0.00012 J mg/L), As (0.0019 mg/L), Ba (0.032 mg/L), Cd (0.00018 mg/L), Cr (0.00093 mg/L), Co (0.00017 J mg/L), Cu (0.0022 mg/L), Fe (0.0068 J mg/L), Hg (0.000006 J mg/L), Ni (0.0049 mg/L), Se (0.0014 mg/L), and V (0.003 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Beryllium and Pb were not detected.

Sulfate (667 mg/L) and specific conductance (1,870 umhos/cm) exceeded the maximum background concentrations. Chloride (100 mg/L) was detected above the maximum baseline and background concentrations, and it was significantly higher than the levels from March 2018 (38.6 mg/L). The level of sulfate (667 mg/L) was also higher than the EPA Maximum Contaminant Level for this analyte (250 mg/L).

**Summary:**

The September 2018 groundwater sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. Using the attached Table 1, Table 2 and trend graphs, the September 2018 results were compared to previous results, maximum baseline and background concentrations, and the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Well MBMG-2 (upgradient well) had no levels of metals detected above the maximum background concentrations during this sampling event. Sample analyses showed no VOCs, and all results were below the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were not detected in well BSB-A1 (north well). All results from this well were also below the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were observed at well BSB-A5 (northeast well). Levels of cis-1,2-Dichloroethene, Trichloroethene, and Vinyl Chloride were detected above the maximum baseline and background concentrations, while Tetrachloroethene was detected above the maximum background concentration.

Other parameters that had results above the maximum background concentration at well BSB-A5 included specific conductance and sulfate. Sulfate also exceeded the EPA Maximum Contaminant Level for this analyte, and Vinyl Chloride exceeded the Montana Human Health Standard for this analyte.

Eight VOCs were detected in well BSB-A6-R (central well). From the eight VOCs, four (i.e., 1,4-Dichlorobenzene, Dichlorodifluoromethane, cis-1,2-Dichloroethene, and Vinyl Chloride) exceeded the maximum background concentrations. Vinyl Chloride also exceeded the Montana Human Health Standard for this analyte.

The sulfate, specific conductance, and chemical oxygen demand results for well BSB-A6-R exceeded their corresponding maximum background concentrations. Sulfate was also higher than the EPA Maximum Contaminant Level for this analyte.

Well CLK-1 (Clark Tailings east well) had levels of metals (i.e., As, Cd, Co, Fe, Ni, and Zn) detected above the maximum background concentrations, but below the maximum baseline concentrations. Arsenic, Cd, Fe, and Zn were also higher than the EPA Maximum Contaminant Levels and the Montana Human Health Standards. The levels of sulfate and specific conductance were higher than the maximum background concentrations, with sulfate exceeding the EPA Maximum Contaminant Level for this analyte.

The levels of Zn were above the maximum background concentration at well CLK-2 (Clark Tailings north well), but below the maximum baseline concentration. Sulfate and specific conductance were higher than the maximum background concentrations, and sulfate also exceeded the EPA Maximum Contaminant Level for this analyte. Chloride was detected above the maximum baseline and background concentrations.

Samples collected from wells MBMG-2, CLK-1, and CLK-2 were analyzed for Hg. Mercury was detected in wells CLK-1 and CLK-2, but at concentrations below the maximum baseline and background concentrations.

The results from the September 2018 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6-R, CLK-1, and CLK-2 exceed the EPA Maximum Contaminant Levels and/or the Montana Human Health Standards, which is consistent with the results from previous years.

9/1/2018

| SAMPLE NUMBER<br>WELL<br>ANALYTE (units): | BSB-GW-01<br>MBMG-2 | BS08<br>JP | BSB-GW-09<br>Field Blank<br>Trip Blank | GW PROTECTION STANDARDS<br>EPA<br>MCL* | <br>MONTANA<br>HHS |
|---|---|---|---|---|---|
| **DISSOLVED METALS (mg/L)** | | | | | |
| Antimony | < 0.0005 | .0005 | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0013 | .12 | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.15 | .022 | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | .00034 | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | .01 | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00034 J)< 0.0005 | .0005 | (Pace 0.00017 J)< 0.0005 | 0.1 | 0.1 |
| Cobalt | < 0.0005 | .036 | < 0.0005 | --- | --- |
| Copper | (Pace 0.00083 J)< 0.001 | .0018 | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | 2.5 | (Pace 0.0057 J)< 0.05 | 0.3(s) | 0.3 |
| Lead | 0.00014 | .0001 | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | .00001 | < 0.00001 | 0.002 | 0.002 |
| Nickel | (Pace 0.00023 J)< 0.0005 | .03 | (Pace 0.00015 J)< 0.0005 | 0.1 | 0.1 |
| Selenium | 0.0011 | .0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | NR | NR | 0.1 | 0.1 |
| Thallium | NR | NR | NR | 0.002 | 0.002 |
| Tin | NR | NR | NR | | |
| Vanadium | 0.0081 | .001 | < 0.001 | --- | --- |
| Zinc | (Pace 0.0036 J)< 0.005 | 9.4 | 0.014 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | |
| Chloride | 70.8 | 9.1 | < 2 | 250 | --- |
| Chemical Oxygen Demand | < 50 | NR | NR | --- | --- |
| Specific Conductance (umhos/cm) | 900 | 520 | 1.8 | --- | --- |
| Cyanide | < 0.02 | (Pace 0.0124NR | NR | --- | 0.2 |
| Nitrate\Nitrite - N | 1.6 | NR | NR | 10 | 10 |
| pH | 7.1 | | 7.2 | | |
| Sulfate | 146 | 23 | < 2.5 | 250 | --- |
| Sulfide | NR | NR | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | |
| Acetone | < 20 | SA | < 20 | --- | --- |
| Benzene | < 1 | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | SA | < 1 | --- | --- |
| Chloroethane | < 1 | SA | < 1 | --- | --- |
| Chloroform | < 1 | SA | 21.8 | --- | 70 |
| Chloromethane | < 4 | SA | < 4 | --- | --- |
| 1,4-Dichlorobenzene | < 1 | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | SA | < 1 | --- | 1000 |
| 1,1-Dichloroethane | < 1 | SA | < 1 | --- | --- |
| 1,2-Dichloroethane | < 1 | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | SA | < 1 | | |
| 1,2-Dichloropropane | < 4 | SA | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | SA | NR | --- | --- |
| Methylene Chloride | < 4 | SA | < 4 | 5 | 30 |
| Naphthalene | NR | SA | NR | --- | 100 |
| Tetrachloroethene | < 1 | SA | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | SA | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | SA | NR | --- | --- |
| Vinyl Chloride | < 0.2 | SA | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | |
| Picloram | SA | SA | SA | | |
| Dicamba | SA | SA | SA | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | | |
| 2,4-D | SA | SA | SA | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | | |

**KEY:**
- * MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
- NA = Not enough sample available for analysis
- NR = Analysis Not Requested
- ND = Analyte Not Detected
- J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
- SA = Sample Not Taken

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 1: ANALYTICAL DATA AND GROUNDWATER PROTECTION STANDARDS
### DATE SAMPLED: September 20 and 21, 2018

9/1/2018

| SAMPLE NUMBER | BSB-GW-01 | BSB-GW-02 | BSB-GW-03 | BSB-GW-04 | BSB-GW-05 | BSB-GW-06 | BSB-GW-07 | BSB-GW-08 | BSB-GW-09 | GW PROTECTION STANDARDS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WELL ANALYTE (units): | MBMG-2 | BSB-A1 | BSB-A5 | BSB-A6-R | CLK-1 | CLK-2 | BSB-A6R DUP | CLK-1 DUP | Field Blank Trip Blank | EPA MCL* | MONTANA HHS |
| **DISSOLVED METALS (mg/L)** | | | | | | | | | | | |
| Antimony | < 0.0005 | SA | SA | SA | (Pace 0.00012 J)< 0.0005 | (Pace 0.00012 J)< 0.0005 | SA | (Pace 0.00016 J)< 0.0005 | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0013 | SA | SA | SA | 0.12 | 0.0019 | SA | 0.12 | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.15 | SA | SA | SA | 0.022 | 0.032 | SA | 0.022 | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | SA | SA | SA | 0.00033 | < 0.0002 | SA | 0.00034 | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | SA | SA | SA | 0.0099 | 0.00018 | SA | 0.01 | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00034 J)< 0.0005 | SA | SA | SA | 0.0013 | 0.00093 | SA | < 0.0005 | (Pace 0.00017 J)< 0.0005 | 0.1 | 0.1 |
| Cobalt | < 0.0005 | SA | SA | SA | 0.036 | (Pace 0.00017 J)< 0.0005 | SA | 0.036 | < 0.0005 | --- | --- |
| Copper | (Pace 0.00083 J)< 0.001 | SA | SA | SA | 0.0019 | 0.0022 | SA | 0.0018 | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | SA | SA | SA | 12.5 | (Pace 0.0068 J)< 0.05 | SA | 12.5 | (Pace 0.0057 J)< 0.05 | 0.3(s) | 0.3 |
| Lead | 0.00014 | SA | SA | SA | (Pace 0.000056 J)< 0.0001 | < 0.0001 | SA | (Pace 0.000073 J)< 0.0001 | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | SA | SA | SA | (Pace 0.000006 J)< 0.00001 | (Pace 0.000006 J)< 0.00001 | SA | (Pace 0.000005 J)< 0.00001 | < 0.00001 | 0.002 | 0.002 |
| Nickel | (Pace 0.00023 J)< 0.0005 | SA | SA | SA | 0.03 | 0.0049 | SA | 0.03 | (Pace 0.00015 J)< 0.0005 | 0.1 | 0.1 |
| Selenium | 0.0011 | SA | SA | SA | (Pace 0.00017 J)< 0.0005 | 0.0014 | SA | (Pace 0.00017 J)< 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.1 | 0.1 |
| Thallium | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.002 | 0.002 |
| Tin | NR | SA | SA | SA | NR | NR | SA | NR | NR | | |
| Vanadium | 0.0081 | SA | SA | SA | (Pace 0.00028 J)< 0.001 | 0.003 | SA | (Pace 0.00037 J)< 0.001 | < 0.001 | --- | --- |
| Zinc | (Pace 0.0036 J)< 0.005 | SA | SA | SA | 40.5 | 0.12 | SA | 39.4 | 0.014 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | | | | | | |
| Chloride | 70.8 | 20.6 | 41.7 | 41.3 | 28.9 | 100 | SA | 29.1 | < 2 | 250 | --- |
| Chemical Oxygen Demand | < 50 | < 50 | (Pace 27.7 J)< 50 | 469 | NR | NR | SA | NR | NR | --- | --- |
| Specific Conductance (umhos/cm) | 900 | 517 | 1600 | 3900 | 1530 | 1870 | SA | 1520 | 1.8 | --- | --- |
| Cyanide | < 0.02 | (Pace 0.0124 J)< 0.02 | < 0.02 | < 0.02 | NR | NR | SA | NR | NR | --- | 0.2 |
| Nitrate\Nitrite - N | 1.6 | 0.26 | 0.26 | 0.26 | NR | NR | SA | NR | NR | 10 | 10 |
| pH | 7.1 | 7.2 | 6.5 | 4.7 | 6.1 | 6.8 | SA | 6 | 7.2 | | |
| Sulfate | 146 | 78.5 | 606 | 2580 | 626 | 667 | SA | 623 | < 2.5 | 250 | --- |
| Sulfide | NR | NR | NR | NR | NR | NR | NR | NR | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | | | | | | |
| Acetone | < 20 | < 20 | < 20 | < 20 | SA | SA | < 20 | SA | < 20 | --- | --- |
| Benzene | < 1 | < 1 | < 1 | (Pace 0.48 J)< 1 | SA | SA | (Pace 0.48 J)< 1 | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | --- | --- |
| Chloroethane | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | --- | --- |
| Chloroform | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | 21.8 | --- | 70 |
| Chloromethane | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | --- | --- |
| 1,4-Dichlorobenzene | < 1 | < 1 | < 1 | 2.2 | SA | SA | 2.2 | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | < 1 | 1.3 | SA | SA | 1.3 | SA | < 1 | --- | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | (Pace 0.4 J)< 1 | (Pace 0.84 J)< 1 | SA | SA | (Pace 0.87 J)< 1 | SA | < 1 | --- | --- |
| 1,2-Dichloroethane | < 1 | < 1 | 1.5 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | < 1 | 4.9 | 2.9 | SA | SA | 2.9 | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | < 1 | < 1 | SA | SA | (Pace 0.14 J)< 1 | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | | |
| 1,2-Dichloropropane | < 4 | < 4 | (Pace 0.25 J)< 4 | (Pace 0.39 J)< 4 | SA | SA | (Pace 0.29 J)< 4 | SA | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | NR | NR | NR | SA | SA | NR | SA | NR | --- | --- |
| Methylene Chloride | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | 5 | 30 |
| Naphthalene | NR | NR | NR | NR | SA | SA | NR | SA | NR | --- | 100 |
| Tetrachloroethene | < 1 | < 1 | 1.6 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | < 0.4 | 1.3 | 0.43 | SA | SA | (Pace 0.38 J)< 0.4 | SA | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | NR | NR | NR | SA | SA | NR | SA | NR | --- | --- |
| Vinyl Chloride | < 0.2 | < 0.2 | 0.43 | 1.7 | SA | SA | 1.8 | SA | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | SA | SA | SA | SA | SA | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | | | | | | |
| Picloram | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| Dicamba | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4-D | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |

**KEY:**

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

mg/L = milligram per Liter
µg/L = microgram per Liter
EPA = U.S. Environmental Protection Agency
MCL = Maximum Contaminant Levels
HHS = Montana Human Health Standards

## BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 3: GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
DATE SAMPLED: September 20 and 21, 2018

| Well ID | Sample # | Depth (ft) | Diameter (ft) | SWL (ft) | TOC Elevation (ft) | Groundwater Elevation (ft) | pH (su) | ORP (mV) | DO (mg/L) | SC (mS/cm) | T (Celsius) | Sample Time | $H_2O$ Volume Required (gal) | $H_2O$ Volume Purged (gal) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MBMG-2 | BSB-GW-01 | 23.20 | 0.17 | 11.04 | 5529.88 | 5518.84 | 7.09 | 311.1 | 7.33 | 0.999 | 10.7 | 10:25 | 6.00 | 7.50 | |
| BSB-A1 | BSB-GW-02 | 53.00 | 0.17 | 32.43 | 5531.50 | 5499.07 | 6.93 | 281.0 | 2.22 | 0.565 | 9.8 | 13:03 | 10.30 | 20.00 | |
| BSB-A5 | BSB-GW-03 | 46.35 | 0.17 | 36.02 | 5524.62 | 5488.60 | 6.24 | 313.3 | 4.77 | 1.893 | 9.2 | 12:20 | 5.17 | 5.20 | |
| BSB-A6-R | BSB-GW-04 | 59.40 | 0.17 | 46.95 | 5554.41 | 5507.46 | 5.71 | 90.2 | 1.69 | 4.500 | 11.8 | 14:40 | 6.23 | 8.50 | |
| BSB-A6-R | BSB-GW-07 | 59.40 | 0.17 | 46.95 | 5554.41 | 5507.46 | 5.71 | 90.2 | 1.69 | 4.500 | 11.8 | 14:45 | 6.23 | 8.50 | VOC Duplicate |
| CLK-1 | BSB-GW-05 | 18.91 | 0.17 | 2.39 | 5478.73 | 5476.34 | 6.21 | 40.5 | 1.52 | 1.682 | 10.3 | 10:15 | 8.26 | 9.00 | |
| CLK-2 | BSB-GW-06 | 47.74 | 0.17 | 36.87 | 5511.17 | 5474.30 | 6.43 | 216.4 | 4.11 | 1.808 | 9.1 | 9:18 | 5.50 | 8.50 | |
| CLK-1 | BSB-GW-08 | 18.91 | 0.17 | 2.39 | 5478.73 | 5476.34 | 6.21 | 40.5 | 1.52 | 1.682 | 10.3 | 10:18 | 8.26 | 9.00 | Raw and Dissolved Metals Duplicate |
| Blank | BSB-GW-09 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 11:00 | NA | NA | Field Blank |

**KEY:**

| | |
|---|---|
| ft | feet |
| SWL | static water level |
| TOC | top of casing |
| pH | Potential of Hydrogen |
| su | standard unit |
| ORP | Oxidation Reduction Potential |
| mV | millivolts |
| DO | Dissolved Oxygen |
| mg/L | milligrams per Liter |
| SC | Specific Conductance |
| mS/cm | milli-Siemens per centimeter |
| T | temperature |
| $H_2O$ | water |
| gal | gallons |
| NA | measurement not taken |

9/20/18

GW Sampling of OLD LANDFILL

Calibration of field parameter meter

YSI Meter

pH: 4.01 - 3.96; 7.00 - 6.92; 10.00 - 10.13

Conductivity: 1541 - 1601

ORP: 390.8 - 400

DO: 6.17 - 6.94

Today's activities: sample water wells at the Old landfill.

On-site personnel: Patty Navarro } Pioneer
Brian Kremer }

Weather: Partly cloudy, 43°F

Safety: watch for moving vehicles, delineate work area with traffic cones as needed.

PPE: Hard hat, high-vis outwear, long-sleeved work shirt, long pants, safety glasses, nitrile gloves, and work gloves

08:45 → arrived at site and looked for access path to well

09:22 → arrived at MBMG-2

DTW: 11.04'; TD: 23.20'

09:42 → begin purging with 12-volt 3 stage pump at 0.25 L/min.

09:55 → changed rate to 1 L/min

10:23 → stopped purging, 7.5 gal total

9/20/18

Field parameters recorded on field data sheet.

Collected BSB-GW-01 at 10:25

1 - 250ml / Filtered / $HNO_3$ / Dissolved metals

1 - 1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

1 - 250ml / $H_2SO_4$ / $NO_2$ - $NO_3$, COD

1 - 250ml / NaOH / Cyanide

3 - 40ml / HCL / VOCs 8260b

10:45 → arrived at BSB-A1

DTW: 32.30', TD: 53.0'

11:04 → begin purging with 12-volt 5 stage pump at 0.5 gpm

11:30 → stopped purging because pump stopped.

Field parameters recorded on field data sheet.

Collected BSB-GW-02 at 13:03

1 - 1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

1 - 250ml / $H_2SO_4$ / $NO_2$ - $NO_3$, COD

1 - 250ml / NaOH / Cyanide

3 - 40ml / HCL / VOCs 8260b

11:39 → measured DTW at 37.5'. Crew will let well recover and come back to collect samples

11:54 → arrived at BSB-A5

DTW: 36.02, TD: 46.35'

12:00 → begin purging with bailer.

Rite in the Rain

9/20/18

12:18 → stopped purging with bailer and collected field parameters on field data sheet.

Collected BSB-GW-03 at 12:20

1-1 L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$
1-250ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD
1-250ml / NaOH / Cyanide
3-40ml / HCL / VOCs 8260b

12:35 → back to BSB-A1

DTW: 32.43', TD: 53.0'

16 gallons were purged previously.

12:49 → begin to collect field parameter.

Field parameters were recorded on field data sheet.

Collected BSB-GW-02 at 13:03

See page 19 for samples collected

13:25 → arrived at BSB-AGR

DTW: 46.95; TD: 59.40'

13:52 → begin purging with 12-volt 3stage pump at 0.75 L/min.

14:39 → stopped purging, 8.5 gal total

Field parameters recorded on field data sheet.

Collected BSB-GW-04 at 14:40

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$
1-250ml / $H_2SO_4$ / $NO_2$ - $NO_3$, COD
1-250ml / NaOH / Cyanide
3-40ml / HCL / VOCs 8260b

---

9/20/18

Collected BSB-GW-07 at 14:45

(sample BSB-GW-07 is the duplicate sample of well BSB-AGR)

3-40ml / HCL / VOCs 8260b

15:00 → P. Navarro and B. Kremer offsite

15:15 → decontaminated pumps at the Butte office

Patricia Navarro 9/20/18

Rite in the Rain

9/21/18

GW Sampling of OLD LANDFILL

Calibration of field parameter meter

YSI Meter

pH: 4.01 - 4.04; 7.00 - 6.93; 10.00 - 10.11

Conductivity: 1580 - 1506

ORP: 406.1 - 400

DO: 5.98 - 6.30

Today's activities: sample water wells at the Old Landfill / Clark Tailings site

On-site personnel: Patty Navarro } Pioneer
Brian Kremer

Weather: Sunny, 41°F

Safety: using hydrochloric acid to preserve vials, add acid first then water sample, use safety glasses and gloves.

PPE: hard hat, high-vis outwear, long-sleeved work shirt, long pants, safety glasses, nitrile gloves, and work gloves.

08:35 → arrived at CLK-2

DTW 36.87'; TD: 47.74'

08:45 → begin purging with dedicated 12-volt 3 stage pump at 1 L/min

09:16 → stopped purging, 8.5 gal. total. see field data sheet for parameters

Collected BSB-GW-06 at 09:18

1-250ml / Filtered / $HNO_3$ / Dissolved metals

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

09:30 → arrived at CLK-1

DTW: 2.39', TD: 18.91

09:35 → begin purging with dedicated 12-vol
3 stage pump at 1 L/min

10:14 → stopped purging, 9 gal. total

Field parameters recorded on field data sheet.

Collected BSB-GW-05 at 10:15

1-250ml / Filtered / $HNO_3$ / Dissolved meta

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

Collected BSB-GW-08 at 10:18

(sample BSB-GW-08 is the duplicate sample of well CLK-1)

1-250ml / Filtered / $HNO_3$ / Dissolved metal

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

10:25 → P. Navarro and B. Kremer off-site

11:00 → collected BSB-GW-09 by pouring DI water into bottles for field blanks.

1-250ml / $HNO_3$ / Dissolved metals

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

3-40ml / HCl / VOCs 8260b

9/24/18 @ 11:38 → P. Navarro dropped off coolers (2) at FedEx. Tracking numbers: 747593947906 and 747593947928

9/25/18 → Both coolers were delivered to Pace Analytical at 09:54.

Patricia Navarro PB
9/25/18

Rite in the Rain

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Old Landfill

WELL/STATION: MBMG-2 DATE: 9/20/18 TIME: 09:22

SAMPLERS: PN / BK WEATHER CONDITIONS: Partly Cloudy 43°F

PHOTO: YES ______ NO X NUMBER: ______

---

### PURGE DATA:

WELL DEPTH: 23.20 FEET

PURGE METHOD: 12-volt, 3 stage pump

DEPTH TO WATER: 11.04 FEET

START PURGING: 942

COLUMN DEPTH: 12.16 FEET

PURGE RATE: .25 L/min ~~GPM~~

CASING DIAMETER: 2 INCH

RATE CHANGE: 1) TIME: 955 RATE: 1L/min

PUMP SET AT: 22 FEET

2) TIME: ______ RATE: ______

3 WELL VOLUMES: 6 GALLONS

SAMPLE TIME: 1025

TOTAL PURGE VOLUME: 7.5 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-01 | 250 ml | ✓ | $HNO_3$ | Dissolved Metals |
| ↓ | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| | 250ml | | $H_2SO_4$ | $NO_2$ - $NO_3$, COD |
| | 250ml | | NaOH | Cyanide |
| | 3-40ml | | HCL | VOCs 8260b |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC ms (~~µS~~/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1007 | 3.5 gal | 10.72 | 6.93 | 0.990 | 303.5 | 7.98 |
| 1011 | 4.5 gal | 10.82 | 7.01 | 0.993 | 304.9 | 7.53 |
| 1015 | 5.5 gal | 10.80 | 7.05 | 0.994 | 306.7 | 7.42 |
| 1019 | 6.5 gal | 10.78 | 7.08 | 0.996 | 309.3 | 7.36 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1023 | 7.5 gal | 10.73 | 7.09 | 0.999 | 311.1 | 7.33 |

FIELD REMARKS: ______

**PIONEER TECHNICAL SERVICES, INC.**

**FIELD SAMPLE DATA SHEET**

Page 1 of 2

PROJECT NAME: Old Landfill
WELL/STATION: BSB-A1 DATE: 9/20/18 TIME: 10:45
SAMPLERS: PN/BK WEATHER CONDITIONS: Partly cloudy, 43°F
PHOTO: YES ____ NO X NUMBER: ____

---

**PURGE DATA:**

PURGE METHOD: 12-volt 5 stage pump
START PURGING: 11:04
PURGE RATE: 0.5 GPM
RATE CHANGE: 1) TIME: ____ RATE: ____
2) TIME: ____ RATE: ____
SAMPLE TIME: See page 2.

WELL DEPTH: 53 FEET
DEPTH TO WATER: 32.30 FEET
COLUMN DEPTH: 20.7 FEET
CASING DIAMETER: 2 INCH
PUMP SET AT: 50 FEET
3 WELL VOLUMES: 10.35 GALLONS
TOTAL PURGE VOLUME: 20 GALLONS

---

**SAMPLE DATA:**

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-02 | 1 Liter |  | Raw | pH, SC, Cl⁻, $SO_4^{-2}$ |
| ↓ | 250ml |  | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| ↓ | 250ml |  | NaOH | Cyanide |
| ↓ | 3-40ml |  | HCL | VOCs 8260b |
|  |  |  |  |  |

**FIELD PARAMETERS:**

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (~~µS~~ mS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1110 | 4 gal | 9.33 | 6.21 | 0.556 | 288.5 | 3.24 |
| 1113 | 5.5 gal | 9.43 | 5.95 | 0.551 | 126.5 | 2.39 |
| 1116 | 7 gal | 9.48 | 6.14 | 0.551 | 94.2 | 2.04 |
| 1119 | 8.5 gal | 9.50 | 6.30 | 0.551 | 85.8 | 2.00 |
| 1122 | 10 gal | 9.60 | 6.51 | 0.552 | 74.5 | 1.47 |
| 1125 | 11.5 gal | 9.63 | 6.59 | 0.552 | 74.4 | 1.64 |
| 1128 | 13 gal | 9.79 | 6.67 | 0.554 | 72.9 | 1.25 |
| 1131 | 14.5 gal | 9.81 | 6.69 | 0.554 | 75.4 | 1.22 |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** |  |  |  |  |  |  |
| 1134 | 16 gal | 9.84 | 6.71 | 0.554 | 80.0 | 1.19 |

FIELD REMARKS: ____

**PIONEER TECHNICAL SERVICES, INC.**

# FIELD SAMPLE DATA SHEET

Page 2 of 2

PROJECT NAME: Old Landfill

WELL/STATION: BSB - A1 DATE: 9/20/18 TIME: 12:35

SAMPLERS: PN / BK WEATHER CONDITIONS: Partly cloudy, 43°F

PHOTO: YES ______ NO X NUMBER: ______

## PURGE DATA:

PURGE METHOD: ______

START PURGING: ______

PURGE RATE: ______ GPM

RATE CHANGE: 1) TIME: 1249 RATE: 1 L/min

2) TIME: ______ RATE: ______

SAMPLE TIME: 1303

WELL DEPTH: 53.0' FEET

DEPTH TO WATER: 32.43' FEET

COLUMN DEPTH: 20.57 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 50 FEET

3 WELL VOLUMES: 10.30 GALLONS

TOTAL PURGE VOLUME: 20 GALLONS

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB - GW - 02 | 1 Liter | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| | 250ml | | NaOH | Cyanide |
| | 3 - 40ml | | HCL | VOCs 8260 b |
| | | | | |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC mS (~~µS~~/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1249 | 17 gal | 9.56 | 6.85 | 0.566 | 297.8 | 2.48 |
| 1252 | 17.75 | 9.65 | 6.89 | .564 | 287.5 | 2.30 |
| 1255 | 18.5 | 9.70 | 6.92 | 0.563 | 285.1 | 2.30 |
| 1258 | 19.25 | 9.80 | 6.94 | 0.564 | 282.8 | 2.25 |
| | | | | | | |
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| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1301 | 20.0 | 9.78 | 6.93 | 0.565 | 281.0 | 2.22 |

**FIELD REMARKS:** 11:30 → stopped purging because ~~of~~ pump stopped. Team measured DTW at 37.5'. and left well site to let the well recover. Team came back to BSB - A1 at 12:35 and DTW was measured at 32.43'. Field parameters were measured and when stabled, team collected sample BSB-GW-02.

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Old Landfill

WELL/STATION: BSB - A5 DATE: 9/20/18 TIME: 11:54

SAMPLERS: PN / BK WEATHER CONDITIONS: Partly cloudy, 43°F

PHOTO: YES ______ NO X NUMBER: ______

---

## PURGE DATA:

PURGE METHOD: Bailer

START PURGING: 12:00

PURGE RATE: N/A GPM

RATE CHANGE: 1) TIME: ______ RATE: ______

2) TIME: ______ RATE: ______

SAMPLE TIME: 12:20

WELL DEPTH: 46.35 FEET

DEPTH TO WATER: 36.02 FEET

COLUMN DEPTH: 10.33 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: — FEET

3 WELL VOLUMES: 5.17 GALLONS

TOTAL PURGE VOLUME: 5.2 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-03 | 1 Liter | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| ↓ | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| | 250ml | | NaOH | Cyanide |
| | 3-40ml | | HCL | 8260b |
| | | | | |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC mS (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 12:18 | 5.2 | 9.18 | 6.24 | 1.893 mS/cm | 313.3 | 4.77 |
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 12:18 | 5.2 | 9.18 | 6.24 | 1,893 mS/cm | 313.3 | 4.77 |

FIELD REMARKS: Water was medium brown in color.

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Old Landfill

WELL/STATION: BSB-AGR DATE: 9/20/18 TIME: 13:25

SAMPLERS: PN/BK WEATHER CONDITIONS: Mostly cloudy, 54°F

PHOTO: YES ____ NO X NUMBER: ____

---

**PURGE DATA:**

PURGE METHOD: 12-volt 3 stage pump

START PURGING: 13:52

PURGE RATE: 0.75 L/min ~~GPM~~

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 1440

WELL DEPTH: 59.40 ~~46.95~~ PN FEET

DEPTH TO WATER: 46.95 FEET

COLUMN DEPTH: 12.45 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 55 FEET

3 WELL VOLUMES: 6.23 GALLONS

TOTAL PURGE VOLUME: 8.5 GALLONS

---

**SAMPLE DATA:**

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-04 | 1 Liter | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| ↓ | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| | 250ml | | NaOH | Cyanide |
| | 3-40ml | | HCL | VOCs 8260b |
| BSB-GW-07 | 3-40ml | | HCL | VOCs 8260b |

**FIELD PARAMETERS:**

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC mS (~~μ~~S/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 1423 | 5.5 gal | 11.72 | 5.71 | 4.459 | 84.1 | 2.84 |
| 1427 | 6.25 gal | 11.70 | 5.71 | 4.477 | 89.2 | 2.23 |
| 1431 | 7 gal | 11.74 | 5.70 | 4.490 | 90.5 | 1.83 |
| 1435 | 7.75 gal | 11.75 | 5.70 | 4.494 | 90.2 | 1.75 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1439 | 8.5 gal | 11.80 | 5.71 | 4.500 | 90.2 | 1.69 |

FIELD REMARKS: Water was dark brown. Sample BSB-GW-07 was collected at 1445. Sample BSB-GW-07 is the duplicate for well BSB-AGR, 3-40mL for VOCs.

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: Old Landfill - Clark Tailings
WELL/STATION: CLK-2 DATE: 9/21/18 TIME: 08:35
SAMPLERS: PN/BK WEATHER CONDITIONS: Sunny, 41°F
PHOTO: YES ____ NO X NUMBER: ____

---

### PURGE DATA:

PURGE METHOD: Dedicated 12 volt 3 stage pump
START PURGING: 08:45
PURGE RATE: 1L/min ~~GPM~~
RATE CHANGE: 1) TIME: ____ RATE: ____
2) TIME: ____ RATE: ____
SAMPLE TIME: 918

WELL DEPTH: 47.74 FEET
DEPTH TO WATER: 36.87 FEET
COLUMN DEPTH: 10.87 FEET
CASING DIAMETER: 2 INCH
PUMP SET AT: 45 FEET
3 WELL VOLUMES: 5.5 GALLONS
TOTAL PURGE VOLUME: 8.5 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-06 | 1 L | | Raw | pH, SC, Cl⁻, $SO_4^{-2}$ |
| ↓ | 250ml | ✓ | $HNO_3$ | Dissolved Metals |
| | | | | |
| | | | | |
| | | | | |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC mS (~~µ~~S/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 852 | 2.5gal | 8.55 | 6.23 | 1.529 | 214.3 | 3.33 |
| 856 | 3.5gal | 8.79 | 6.26 | 1.593 | 214.2 | 3.43 |
| 900 | 4.5gal | 9.00 | 6.29 | 1.629 | 215.7 | 3.40 |
| 904 | 5.5gal | 9.06 | 6.34 | 1.690 | 216.4 | 3.76 |
| 908 | 6.5gal | 9.10 | 6.37 | 1.756 | 215.5 | 4.02 |
| 912 | 7.5gal | 9.17 | 6.40 | 1.800 | 215.9 | 4.04 |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 916 | 8.5gal | 9.12 | 6.43 | 1.808 | 216.4 | 4.11 |

FIELD REMARKS: ____

PIONEER TECHNICAL SERVICES, INC.

**FIELD SAMPLE DATA SHEET** Page 1 of 1

PROJECT NAME: Old Landfill - Clark Tailings

WELL/STATION: CLK-1 DATE: 9/21/18 TIME: 09:30

SAMPLERS: PN/BK WEATHER CONDITIONS: Sunny, 41°F

PHOTO: YES ____ NO X NUMBER: ____

---

**PURGE DATA:**

PURGE METHOD: Dedicated 12-volt 3 stage pump

START PURGING: 09:35

PURGE RATE: 1 L/min ~~GPM~~

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 1015

WELL DEPTH: 18.91 FEET

DEPTH TO WATER: 2.39 FEET

COLUMN DEPTH: 16.52 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 16 FEET

3 WELL VOLUMES: 8.26 GALLONS

TOTAL PURGE VOLUME: 9 GALLONS

---

**SAMPLE DATA:**

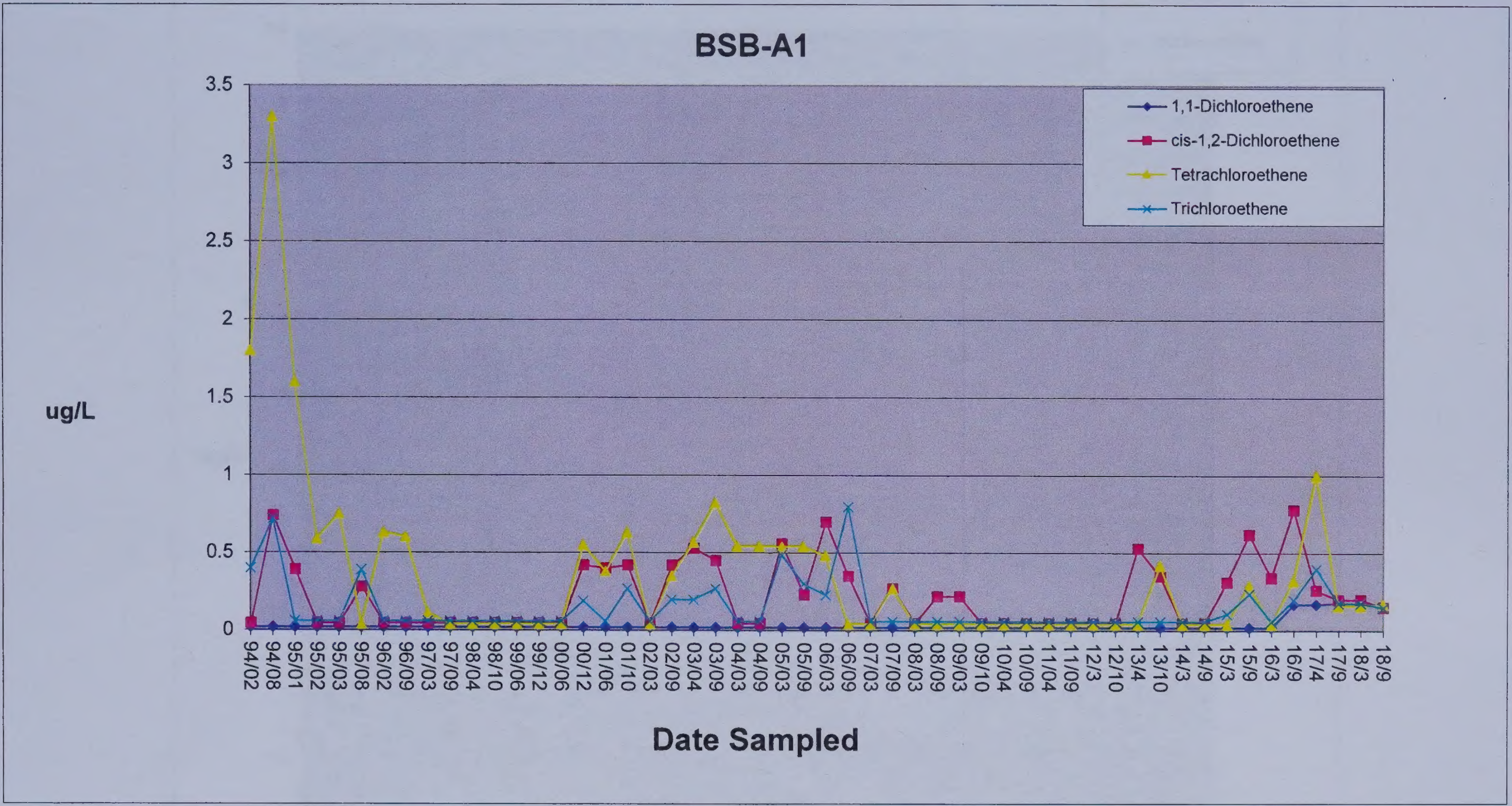
| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-05 | 250ml | ✓ | $HNO_3$ | Dissolved metals |
| ↓ | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| BSB-GW-08 | 250ml | ✓ | $HNO_3$ | Dissolved metals |
| ↓ | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| | | | | |

**FIELD PARAMETERS:**

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC mS (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 958 | 5 gal | 9.99 | 6.18 | 1.672 | 35.0 | 2.86 |
| 1002 | 6 gal | 10.07 | 6.19 | 1.674 | 40.2 | 1.93 |
| 1006 | 7 gal | 10.20 | 6.20 | 1.676 | 40.2 | 1.55 |
| 1010 | 8 gal | 10.23 | 6.21 | 1.676 | 37.7 | 1.51 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 1014 | 9 gal | 10.27 | 6.21 | 1.682 | 40.5 | 1.52 |

FIELD REMARKS: Water was brown when purging started. Sample BSB-GW-08 is the duplicate for well CLK-1 sampled @ 1018

**PIONEER TECHNICAL SERVICES, INC.**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2
1.5
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Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
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98/04
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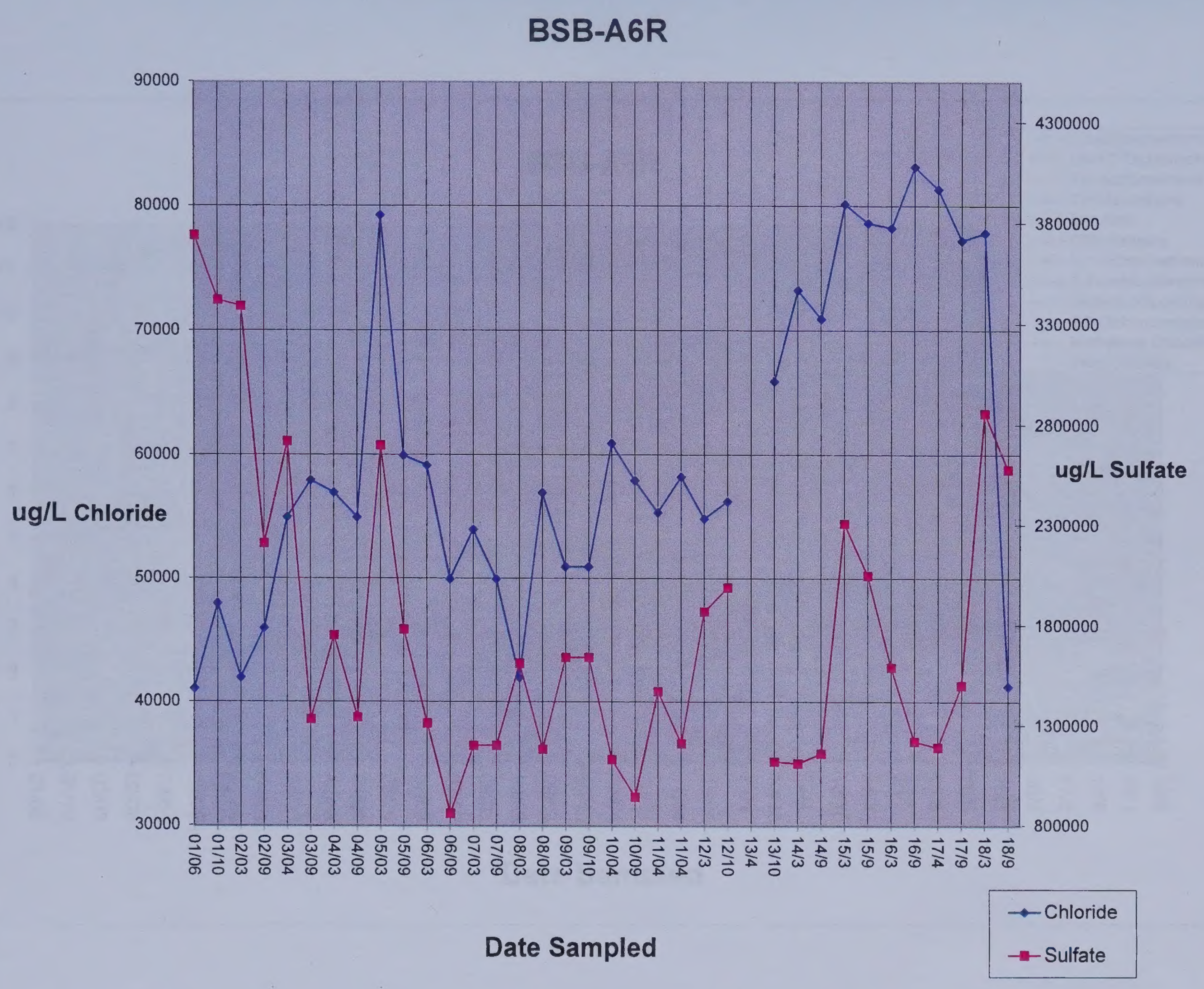
18/3
18/9
Date Sampled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14/3
14/9
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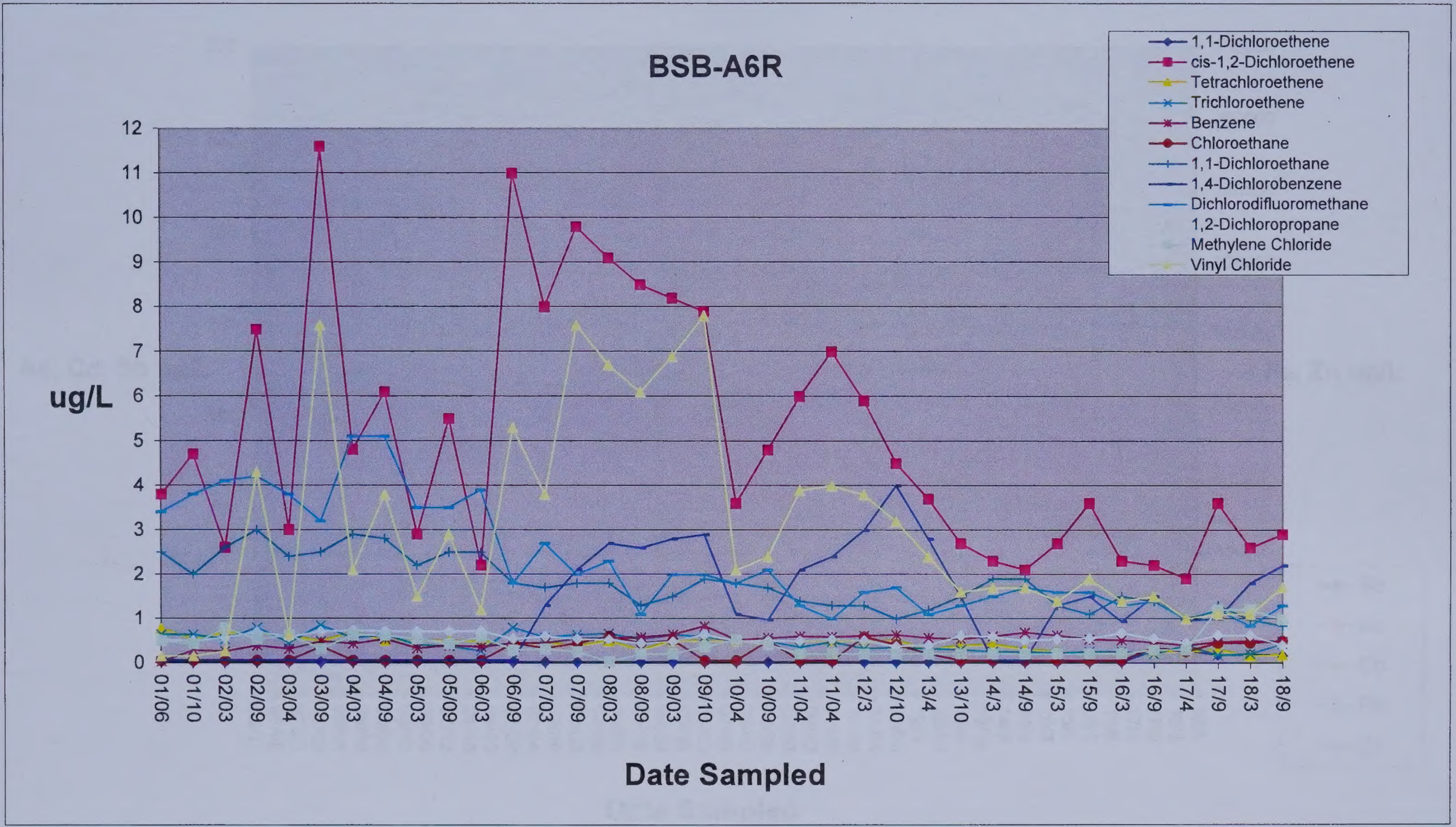
17/9
18/3
18/9
Date Sampled
Chloride
Sulfate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ug/L
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17/9
18/3
18/9
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
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Dichlorodifluoromethane
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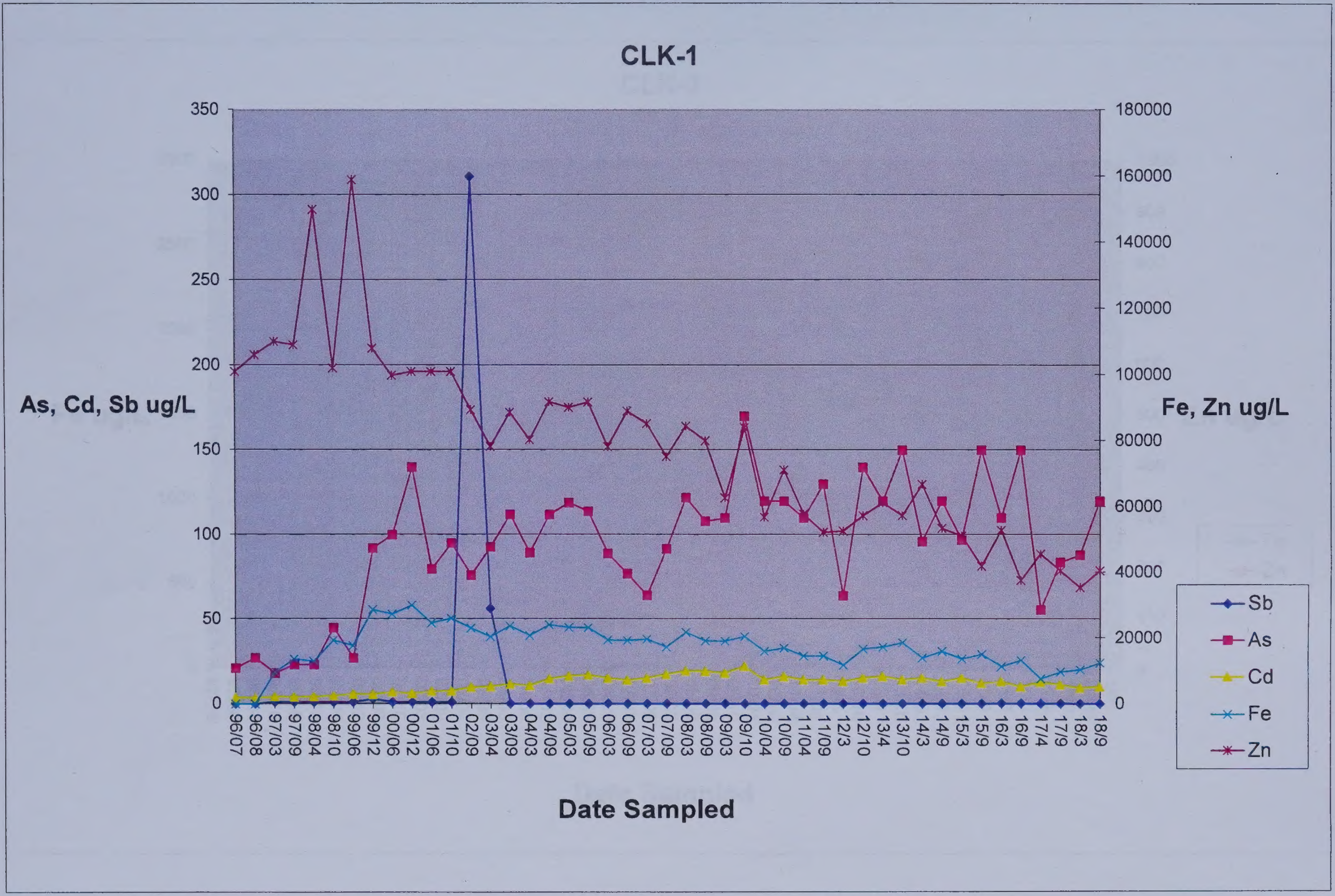
Methylene Chloride
Vinyl Chloride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300
250
200
150
100
50
0
Fe, Zn ug/L
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/09
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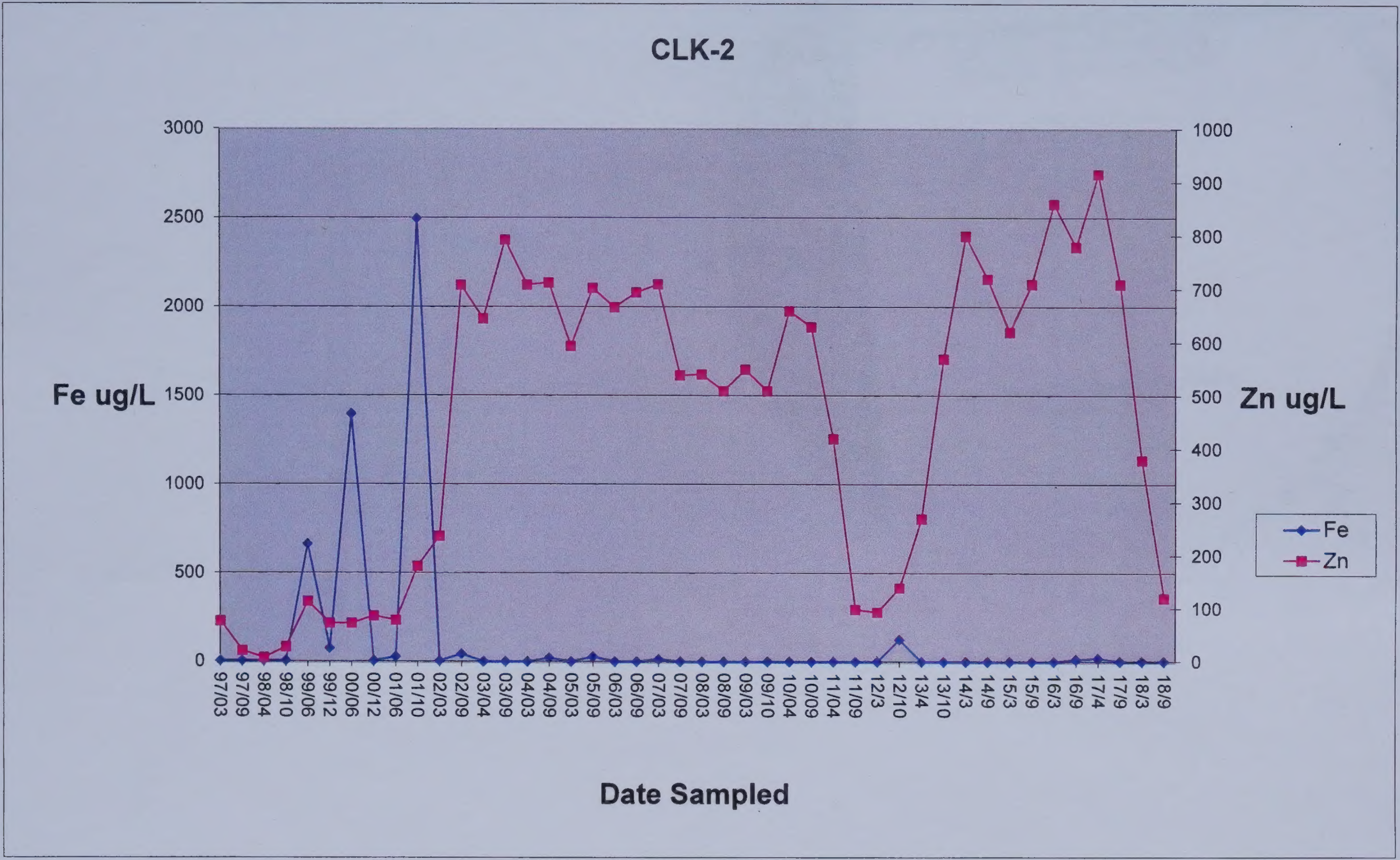
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
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Zn ug/L
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2500
2000
1500
1000
500
0
1000
900
800
700
600
500
400
300
200
100
0
Fe
Zn
97/03
97/09
98/04
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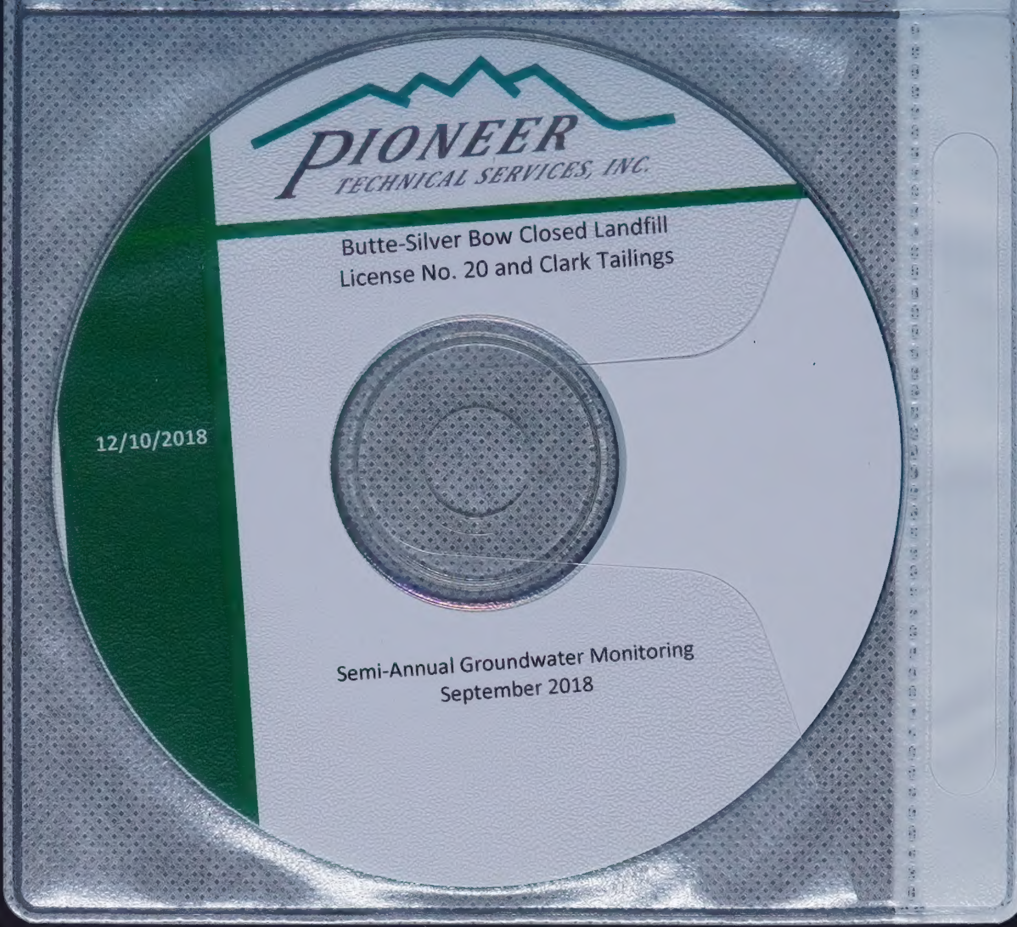
Date Sampled



PIONEER
TECHNICAL SERVICES, INC.

Butte-Silver Bow Closed Landfill
License No. 20 and Clark Tailings

12/10/2018

Semi-Annual Groundwater Monitoring
September 2018

PIONEER
TECHNICAL SERVICES, INC.

County Silver Bow
Facility & # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run-on

May 02, 2018

Mr. John Collins
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear John:

On March 13 and 14, 2018, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring for the Butte-Silver Bow (BSB) Closed Landfill and the Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from four monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

- A figure showing the location of the groundwater monitoring wells (Figure 1).
- The Groundwater Potentiometric Surface Map for March 2018 (Figure 2).
- A document comparing the March 2018 results to previous results, maximum baseline and background concentrations, and groundwater protection standards (Attachment 1).
- A table comparing the March 2018 analytical data to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards (Table 1).
- A table showing the groundwater monitoring data and a non-parametric comparison of the monitoring wells (Table 2) (included electronically with this letter).
- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- Copy of field notes and field sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2.

PIONEER
TECHNICAL SERVICES, INC.

RECEIVED
MAY 07 2018
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

May 02, 2018

Mr. John Collins
Montana Department of Environmental Quality
Solid Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901

**RE: Semi-Annual Groundwater Monitoring for the Butte-Silver Bow Closed Landfill (License No. 20) and Clark Tailings**

Dear John:

On March 13 and 14, 2018, Pioneer Technical Services, Inc. (Pioneer) conducted the semi-annual groundwater monitoring for the Butte-Silver Bow (BSB) Closed Landfill and the Clark Tailings site. This groundwater monitoring event consisted of collecting depth-to-groundwater measurements, field parameters, and water quality samples from four monitoring wells at the BSB Closed Landfill (wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6R) and from two monitoring wells at the Clark Tailings site (wells CLK-1 and CLK-2) (Figure 1). Pioneer followed the procedures outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan – Butte-Silver Bow* (Pioneer, 2015) to collect the groundwater monitoring data. The groundwater monitoring data and water quality results have been used to develop a groundwater potentiometric map, calculate groundwater velocities, monitor groundwater quality trends, and conduct statistical analyses of the groundwater monitoring data. As part of this groundwater monitoring report, the following support documents have been included for your review:

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- A summary table with groundwater field chemistry results, groundwater elevations, and purge volumes (Table 3).
- Copy of field notes and field sample data sheets.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).
- Water quality trend graphs for monitoring wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2.

The following sections provide a summary of the groundwater velocity calculations and statistical analysis conducted by Pioneer for the BSB Closed Landfill and the Clark Tailings site.

## Groundwater Velocity Calculations

Using the depth-to-groundwater measurements collected during the March 2018 monitoring event, a groundwater potentiometric surface map was developed (Figure 2). Based on Figure 2, groundwater flows in a northern direction at a hydraulic gradient ranging from 2.85E-02 feet per foot (ft/ft) to 3.34E-02 ft/ft. This is consistent with the past groundwater flow direction and range of hydraulic gradients. Using the hydraulic gradients, two groundwater velocities were calculated using both Darcy's Law and the equation for the seepage velocity. The average groundwater velocity for the March 2018 sampling event was 0.29 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the average groundwater velocity was acquired from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

## Water Quality Results

The March 2018 sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The March 2018 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well, MBMG-2) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

The results from March 2018 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6-R, CLK-1, and CLK-2 exceed the EPA Maximum Contaminant Levels and/or the Montana Human Health Standards.

Please refer to Attachment 1 for a summary and analysis of the March 2018 results.

**Statistical Analysis**

Pioneer has calculated a confidence level of 98.0 % per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

If you have any questions or concerns, please contact me at (406) 497-8056.

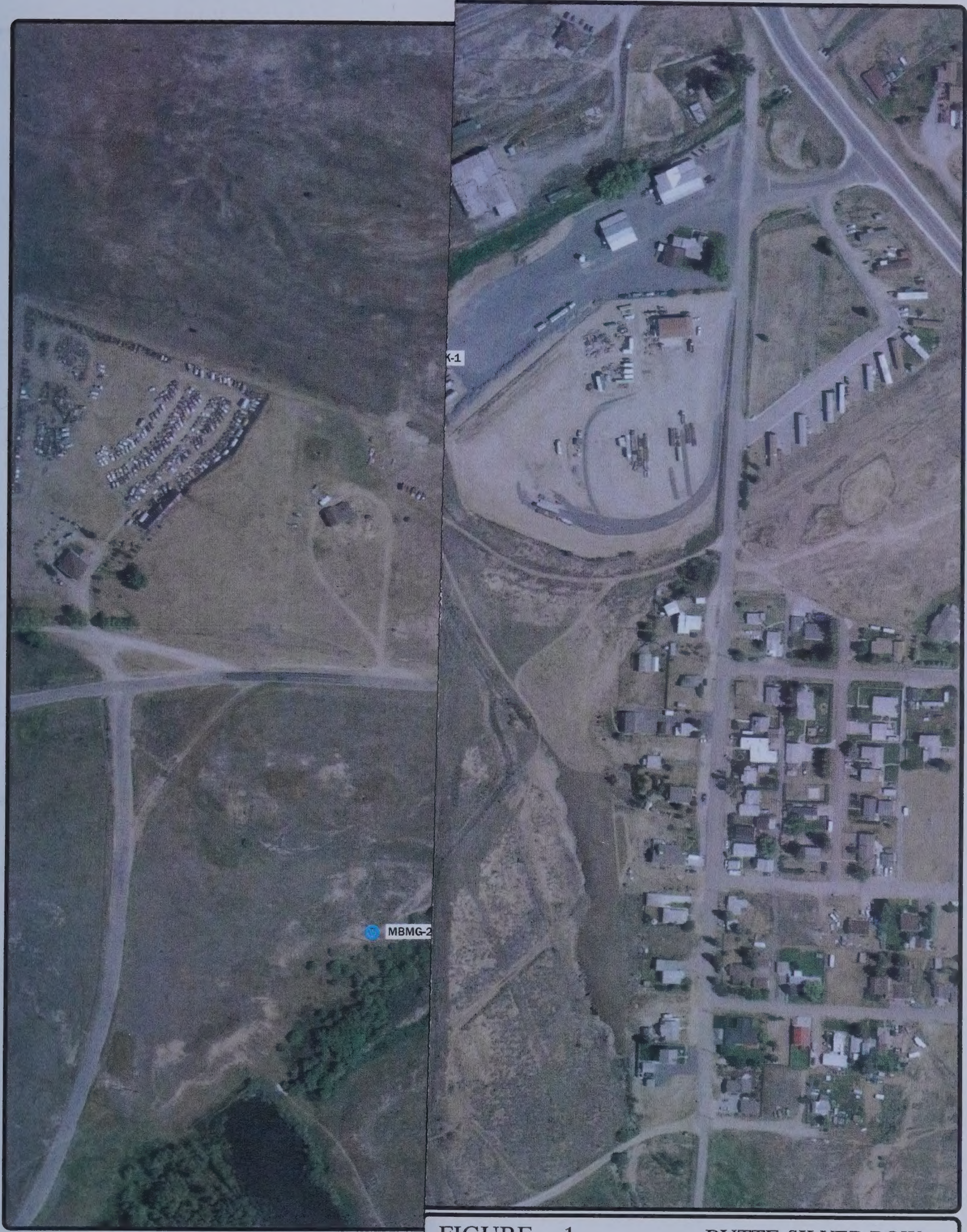
Sincerely,

Patricia Navarro

Patty Navarro
Staff Engineer

Encl.

cc. Dave Schultz, BSB Public Works Director
Glen Rafish, BSB Landfill Manager
Joseph S. McElroy, Pioneer Project Manager (email)
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, Montana 59701
Josh Bryson, Atlantic Richfield (email)
Loren Burmeister, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com



LEGEND

▨ GROUNDWATER MONITORING WELLS

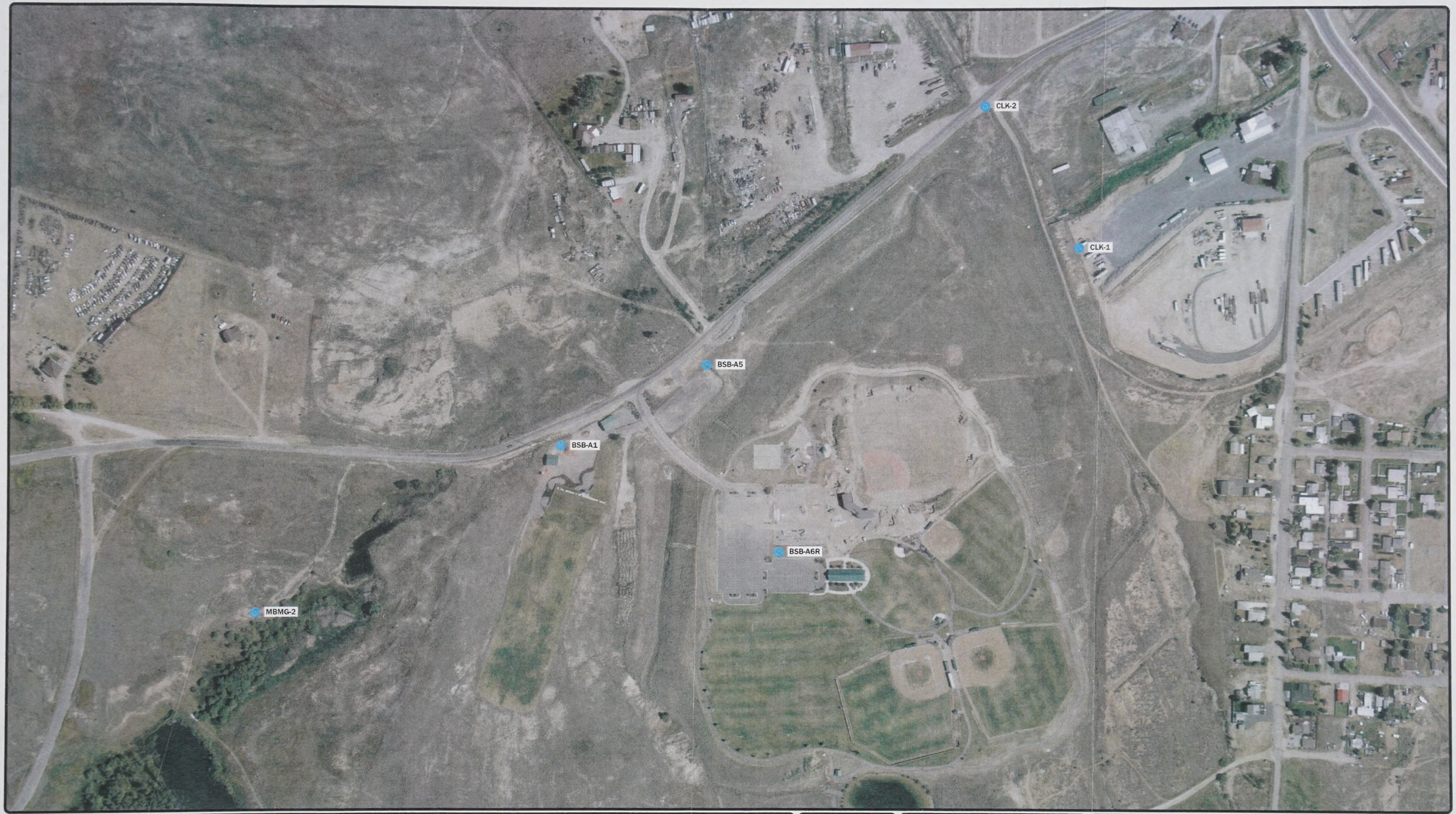
FIGURE 1

# BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LAN



LEGEND

● GROUNDWATER MONITORING WELLS

| | |
|---|---|
| | DISPLAYED AS: |
| COORD SYS/ZONE: | MSP83 |
| DATUM: | NAVD88 |
| UNITS: | IF |
| SOURCE: | PIONEER/AES |

SCALE IN FEET
0 100 200

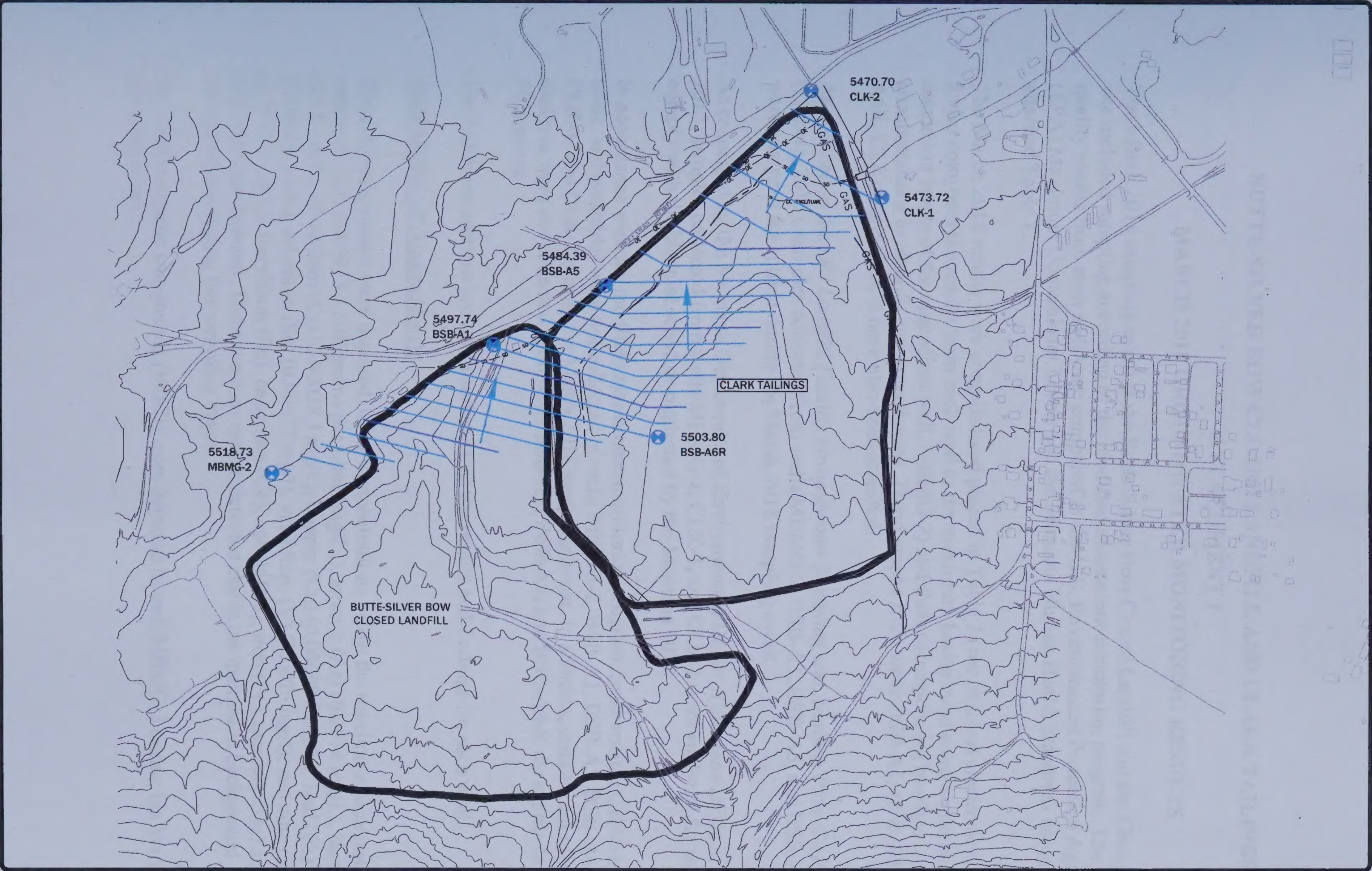
FIGURE 1

# BUTTE-SILVER BOW CLOSED LANDFILL/CLARK TAILINGS GROUNDWATER MONITORING WELLS

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/10/2018 11:29:23 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-001-18.DWG


5470.70
CLK-2
5473.72
CLK-1
5484.39
BSB-A5
5497.74
BSB-A1
CLARK TAILINGS
5503.80
BSB-A6R
5518.73
MBMG-2
BUTTE-SILVER BOW
CLOSED LANDFILL
GAS

## LEGEND

CLK-1 GROUNDWATER MONITORING WELL

CONTOUR

CONTOUR INTERVAL= 10'

| DISPLAYED AS: | |
|---|---|
| COORD SYS/ZONE: | NA |
| DATUM: | NA |
| UNITS: | FEET |
| SOURCE: | PIONEER |

SCALE IN FEET
0 300 600

FIGURE 2

## MARCH 2018 GROUNDWATER POTENTIOMETRIC SURFACE MAP

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/2018

4/23/2018 9:15:47 AM P:\BUTTE-SILVER BOW\2018\LANDFILLS\CLOSED LANDFILL - LICENSE 20\GW SAMPLING\MARCH 2018 GW SAMPLING\WORKING FILES\DWG\LNDFL-GW-PLN-002-18.DWG

# BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## ATTACHMENT 1
## MARCH 2018 GROUNDWATER MONITORING RESULTS

The March 2018 sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. The water quality results from each well were compared to the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels and the Montana Human Health Standards using the attached Table 1.

The March 2018 results were compiled and placed in Table 2 (see attached electronic file). Table 2 also compares the results from each well to the maximum background concentrations (i.e., the maximum levels of the upgradient well, MBMG-2) and their corresponding baseline concentrations to identify any exceedances. Trend graphs from wells BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 have also been attached.

As outlined in the *Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP)* (Pioneer, 2015), samples collected from wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6-R were analyzed for sulfide during the March 2018 sampling event.

As requested by the Montana Department of Environmental Quality (Montana DEQ) in May 2013, samples collected from wells MBMG-2, CLK-1, and CLK-2 were analyzed for mercury to comply with the biennial schedule requested by the Montana DEQ.

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in wells MBMG-2, BSB-A1, BSB-A5, BSB-A6-R, CLK-1, and CLK-2 during the March 2018 sampling event. In addition, samples for metals analyses were not collected from wells BSB-A1, BSB-A5, and BSB-A6-R during the March 2018 event.

The following sections provide a summary of the results and findings for each well.

**Well MBMG-2 (Upgradient):**

The following metals were detected, but at concentrations below the maximum background: antimony (Sb) (0.00013 J milligrams per Liter [mg/L]), arsenic (As) (0.0014 mg/L), barium (Ba) (0.15 mg/L), chromium (Cr) (0.00028 J mg/L), copper (Cu) (0.00098 J mg/L), lead (Pb) (0.00014 mg/L), selenium (Se) (0.00077 mg/l), vanadium (V) (0.0075 mg/l), and zinc (Zn) (0.0014 J mg/L). Beryllium (Be), cadmium (Cd), cobalt (Co), iron (Fe), mercury (Hg) and nickel (Ni) were not detected. There were no metals detected above the maximum background concentrations during this sampling event.

No volatile organic compounds (VOCs) were detected in well MBMG-2 during the March 2018 sampling event.

Nitrate/nitrite (4.4 mg/L), chloride (57.6 mg/l), sulfate (140 mg/L), and cyanide (0.0048 J mg/L) were detected, but at concentrations below the maximum background. Sulfide was not detected in well MBMG-2.

Analytical results from well MBMG-2 did not exceed any of the EPA Maximum Contaminant Levels or the Montana Human Health Standards during the March 2018 sampling event.

**Well BSB-A1 (North Well):**

Volatile organic compounds were not detected in well BSB-A1 during the March 2018 sampling event. Sulfide was also not detected in this well.

The March 2018 results from well BSB-A1 were compared to the EPA Maximum Contaminant Levels and the Montana Human Health Standards and no exceedances were observed.

The results from March 2018 are consistent with the results from 2017.

**Well BSB-A5 (Northeast Well):**

Levels of cis-1,2-Dichloroethene (3.4 micrograms per Liter [µg/L]) were detected above the maximum baseline and background concentrations. Levels of Tetrachloroethene (1.1 µg/L) were detected above the maximum background concentration. The following VOCs were also detected, but at concentrations below the maximum baseline and background concentrations: 1,1-Dichloroethane (0.27 J µg/L) and Trichloroethene (0.66 µg/L). The attached trend graph for well BSB-A5 shows that the levels of cis-1,2-Dichloroethene, Tetrachloroethene, and Trichloroethene are continuing to trend upward.

Specific conductance (1,720 micromhos per centimeter [umhos/cm]) and sulfate (653 mg/L) were detected above the maximum background concentrations. Nitrate/nitrite (0.95 mg/L), chloride (42.6 mg/L), and cyanide (0.004 J mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Sulfide was not detected in well BSB-A5.

Results from the March 2018 sampling event also show that the level of sulfate (653 mg/L) exceeded the EPA Maximum Contaminant Level for this analyte (250 mg/L).

**Well BSB-A6-R (Central Well):**

Well BSB-A6-R is the replacement well for BSB-A6, which was removed during construction of the Timber Butte Youth Park.

The following VOCs were detected in well BSB-A6-R during the March 2018 sampling event:

- Benzene (0.49 J µg/L).
- 1,4-Dichlorobenzene (1.8 µg/L) exceeds the maximum background concentration.
- Dichlorodifluoromethane (0.84 J µg/L).
- 1,1-Dichloroethane (0.98 J µg/L).

- cis-1,2-Dichloroethene (2.6 µg/L) exceeds the maximum background concentration.
- Trichloroethene (0.21 J µg/L).
- Vinyl Chloride (1.1 µg/L) exceeds the maximum background concentration.

The attached trend graph for well BSB-A6R indicates that the VOC results are consistent with the results from the 2017 sampling events.

Vinyl chloride (1.1 µg/L) also exceeded the Montana Human Health Standard for this analyte (0.2 µg/L).

The levels of sulfate (2,860 mg/L), specific conductance (3,960 umhos/cm), and chemical oxygen demand (625 mg/L) were significantly higher than the results from the previous sampling events. For example, results from the September 2017 sampling event included: sulfate (1,500 mg/L), specific conductance (2,680 umhos/cm) and chemical oxygen demand (388 mg/L); and the results from the April 2017 sampling event included: sulfate (1,190 mg/L), specific conductance (2,470 mg/L) and chemical oxygen demand (386 mg/L). Sulfate, specific conductance, and chemical oxygen demand also exceeded their corresponding maximum background concentrations during the March 2018 sampling event.

Nitrate/nitrite (0.22 mg/L), chloride (77.9 mg/L), and cyanide (0.012 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Sulfide was not detected in well BSB-A6-R.

Results from the March 2018 sampling event also show that the level of sulfate (2,860 mg/L) exceeded the EPA Maximum Contaminant Level for this analyte (250 mg/L).

**Well CLK-1 (Clark Tailings East Well):**

Metals detected above the maximum background concentrations, but below the maximum baseline concentrations include: As (0.088 mg/L), Cd (0.0091 mg/L), Co (0.033 mg/L), Fe (10.5 mg/L), Ni (0.029 mg/L), and Zn (35.4 mg/L).

Antimony (0.00013 J mg/L), Ba (0.021 mg/L), Be (0.00034 mg/L), and Cu (0.0018 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Chromium, Pb, Hg, Se, and V were not detected during the March 2018 sampling event.

Arsenic, Cd, Fe, and Zn also exceeded the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

The levels of sulfate (615 mg/L) and specific conductance (1,550 umhos/cm) exceeded the maximum background concentrations. Chloride (29.3 mg/L) was detected, but at concentrations below the maximum baseline and background. The level of sulfate (615 mg/L) was also higher than the EPA Maximum Contaminant Level for this analyte (250 mg/L).

The attached trend graph for well CLK-1 indicates that the results are consistent with the results from previous sampling events.

**Well CLK-2 (Clark Tailings North Well):**

Nickel (0.024 mg/L) and Zn (0.38 mg/L) were detected at well CLK-2 above the maximum background concentrations, but below the maximum baseline concentrations. The attached trend graph for well CLK-2 also indicate that the levels of Zn decreased significantly when compared to the 2017 results. For example, Zn levels went from 0.71 mg/L during September 2017 to 0.38 mg/L.

Antimony (0.00012 J mg/L), As (0.0017 mg/L), Ba (0.016 mg/L), Cd (0.00068 mg/L), Cr (0.0006 mg/L), Co (0.00024 J mg/L), Cu (0.003 mg/L), Hg (0.000007 J mg/L), Se (0.00022 J mg/L), and V (0.0019 mg/L) were detected, but at concentrations below the maximum baseline and background concentrations. Beryllium, Fe, and Pb were not detected.

Sulfate (600 mg/L) and specific conductance (1,560 umhos/cm) exceeded the maximum background concentrations. Chloride (38.6 mg/L) was detected, but at concentrations below the maximum baseline and background. The level of sulfate (600 mg/L) was also higher than the EPA Maximum Contaminant Level for this analyte (250 mg/L).

**Summary and Conclusion:**

The March 2018 sampling event at the Butte-Silver Bow Closed Landfill and the Clark Tailings site included sampling according to the modified assessment-monitoring program. Using the attached Table 1, Table 2 and trend graphs, the March 2018 results were compared to previous results, maximum baseline and background concentrations, and the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Well MBMG-2 (Upgradient Well) had no levels of metals detected above the maximum background concentrations during this sampling event. Sample analyses showed no VOCs, and all results were below the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were not detected in well BSB-A1 (North Well). All results from this well were also below the EPA Maximum Contaminant Levels and the Montana Human Health Standards.

Volatile organic compounds were observed at well BSB-A5 (Northeast Well). Levels of cis-1,2-Dichloroethene were detected above the maximum baseline and background concentrations, while Tetrachloroethene was detected above the maximum background concentration.

Other parameters that had results above the maximum background concentration at well BSB-A5 included specific conductance and sulfate. Sulfate also exceeded the EPA Maximum Contaminant Level for this analyte.

Seven VOCs were detected in well BSB-A6-R (Central Well). From the seven VOCs, three (i.e., 1,4-Dichlorobenzene, cis-1,2-Dichloroethene, and Vinyl Chloride) exceeded the maximum

background concentrations. Vinyl Chloride also exceeded the Montana Human Health Standard for this analyte.

The sulfate, specific conductance, and chemical oxygen demand results for well BSB-A6-R were significantly higher than the results from the previous sampling events. For example, sulfate was 2,860 mg/L in March 2018 and 1,500 mg/L during September 2017. Sulfate, specific conductance, and chemical oxygen demand also exceeded their corresponding maximum background concentrations. Sulfate was also higher than the EPA Maximum Contaminant Level for this analyte.

Sulfide was not detected in samples collected from wells MBMG-2, BSB-A1, BSB-A5, and BSB-A6-R.

Well CLK-1 (Clark Tailings East Well) had levels of metals (i.e., As, Cd, Co, Fe, Ni, and Zn) detected above the maximum background concentrations, but below the maximum baseline concentrations. Arsenic, Cd, Fe, and Zn were also higher than the EPA Maximum Contaminant Levels and the Montana Human Health Standards. The levels of sulfate and specific conductance were higher than the maximum background concentrations, with sulfate exceeding the EPA Maximum Contaminant Level for this analyte.

The levels of Ni and Zn were above the maximum background concentrations at well CLK-2 (Clark Tailings North Well), but below the maximum baseline concentrations. Sulfate and specific conductance were higher than the maximum background concentrations, and sulfate also exceeded the EPA Maximum Contaminant Level for this analyte.

Samples collected from wells MBMG-2, CLK-1, and CLK-2 were analyzed for mercury. Mercury was only detected in well CLK-2, but at concentrations below the maximum baseline and background concentrations.

The results from March 2018 sampling event indicate that the groundwater quality from wells BSB-A5, BSB-A6-R, CLK-1, and CLK-2 exceed the EPA Maximum Contaminant Levels and/or the Montana Human Health Standards.

3/1/2018

| SAMPLE NUMBER<br>WELL<br>ANALYTE (units): | BSB-GW-01<br>MBMG-2 | BSB-GW-<br>BSB-A | BSB-GW-09<br>Field Blank<br>Trip Blank | GW PROTECTION STANDARDS<br>EPA<br>MCL* | <br>MONTANA<br>HHS |
|---|---|---|---|---|---|
| **DISSOLVED METALS (mg/L)** | | | | | |
| Antimony | (Pace 0.00013 J)< 0.0005 | S | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0014 | S | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.15 | S | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | S | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | S | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00028 J)< 0.0005 | S | 0.0023 | 0.1 | 0.1 |
| Cobalt | < 0.0005 | S | < 0.0005 | --- | --- |
| Copper | (Pace 0.00098 J)< 0.001 | S | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | S | < 0.05 | 0.3(s) | 0.3 |
| Lead | 0.00014 | S | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | S | < 0.00001 | 0.002 | 0.002 |
| Nickel | < 0.0005 | S | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.00077 | S | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | S | NR | 0.1 | 0.1 |
| Thallium | NR | S | NR | 0.002 | 0.002 |
| Tin | NR | S | NR | | |
| Vanadium | 0.0075 | S | < 0.001 | --- | --- |
| Zinc | (Pace 0.0014 J)< 0.005 | S | (Pace 0.002 J)< 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | |
| Chloride | 57.6 | 2 | 1.1 | 250 | --- |
| Chemical Oxygen Demand | < 50 | < 5 | NR | --- | --- |
| Specific Conductance (umhos/cm) | 918 | 5 | 3.6 | --- | --- |
| Cyanide | (Pace 0.0048 J)< 0.01 | 0 | NR | --- | 0.2 |
| Nitrate\Nitrite - N | 4.4 | 0 | NR | 10 | 10 |
| pH | 6.5 | 6 | 6.2 | | |
| Sulfate | 140 | 7 | < 2.5 | 250 | --- |
| Sulfide | < 0.1 | < 0 | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | |
| Acetone | < 20 | < 2 | < 20 | --- | --- |
| Benzene | < 1 | < 1 | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | < 1 | --- | --- |
| Chloroethane | < 1 | < 1 | < 1 | --- | --- |
| Chloroform | < 1 | < 1 | < 1 | --- | 70 |
| Chloromethane | < 4 | < 4 | < 4 | --- | --- |
| 1,4-Dichlorobenzene | < 1 | < 1 | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | < 1 | --- | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | < 1 | --- | --- |
| 1,2-Dichloroethane | < 1 | < 1 | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | < 1 | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | < 1 | | |
| 1,2-Dichloropropane | < 4 | < 4 | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | N | NR | --- | --- |
| Methylene Chloride | < 4 | < 4 | < 4 | 5 | 30 |
| Naphthalene | NR | N | NR | --- | 100 |
| Tetrachloroethene | < 1 | < 1 | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | < 0 | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | N | NR | --- | --- |
| Vinyl Chloride | < 0.2 | < 0 | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | S | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | |
| Picloram | SA | S | SA | | |
| Dicamba | SA | S | SA | | |
| 2,4,5-TP (Silvex) | SA | S | SA | | |
| 2,4-D | SA | S | SA | | |
| **EPA METHOD 8081 (µg/L)** | | | | | |
| | SA | S | SA | | |
| **EPA METHOD 8082 (µg/L)** | | | | | |
| | SA | S | SA | | |

KEY:
* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

## BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
## TABLE 1: ANALYTICAL DATA AND GROUNDWATER PROTECTION STANDARDS
### DATE SAMPLED: March 13 and 14, 2018

3/1/2018

| SAMPLE NUMBER<br>WELL<br>ANALYTE (units): | BSB-GW-01<br>MBMG-2 | BSB-GW-02<br>BSB-A1 | BSB-GW-03<br>BSB-A5 | BSB-GW-04<br>BSB-A6-R | BSB-GW-05<br>CLK-1 | BSB-GW-06<br>CLK-2 | BSB-GW-07<br>BSB-A6R DUP | BSB-GW-08<br>CLK-1 DUP | BSB-GW-09<br>Field Blank<br>Trip Blank | GW PROTECTION STANDARDS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | EPA<br>MCL* | MONTANA<br>HHS |
| **DISSOLVED METALS (mg/L)** | | | | | | | | | | | |
| Antimony | (Pace 0.00013 J)< 0.0005 | SA | SA | SA | (Pace 0.00013 J)< 0.0005 | (Pace 0.00012 J)< 0.0005 | SA | (Pace 0.00019 J)< 0.0005 | < 0.0005 | 0.006 | 0.014 |
| Arsenic | 0.0014 | SA | SA | SA | 0.088 | 0.0017 | SA | 0.087 | < 0.0005 | 0.05 | 0.01 |
| Barium | 0.15 | SA | SA | SA | 0.021 | 0.016 | SA | 0.021 | < 0.0003 | 2 | 2 |
| Beryllium | < 0.0002 | SA | SA | SA | 0.00034 | < 0.0002 | SA | 0.00038 | < 0.0002 | 0.004 | 0.004 |
| Cadmium | < 0.00008 | SA | SA | SA | 0.0091 | 0.00068 | SA | 0.0092 | < 0.00008 | 0.005 | 0.005 |
| Chromium | (Pace 0.00028 J)< 0.0005 | SA | SA | SA | < 0.0005 | 0.0006 | SA | < 0.0005 | 0.0023 | 0.1 | 0.1 |
| Cobalt | < 0.0005 | SA | SA | SA | 0.033 | (Pace 0.00024 J)< 0.0005 | SA | 0.033 | < 0.0005 | - - - | - - - |
| Copper | (Pace 0.00098 J)< 0.001 | SA | SA | SA | 0.0018 | 0.003 | SA | 0.0018 | < 0.001 | 1.3 (a) | 1.3 |
| Iron | < 0.05 | SA | SA | SA | 10.5 | < 0.05 | SA | 10.5 | < 0.05 | 0.3(s) | 0.3 |
| Lead | 0.00014 | SA | SA | SA | < 0.0001 | < 0.0001 | SA | < 0.0001 | < 0.0001 | 0.015 (a) | 0.015 |
| Mercury | < 0.00001 | SA | SA | SA | < 0.00001 | Pace 0.000007 J)< 0.00001 | SA | < 0.00001 | < 0.00001 | 0.002 | 0.002 |
| Nickel | < 0.0005 | SA | SA | SA | 0.029 | 0.024 | SA | 0.029 | < 0.0005 | 0.1 | 0.1 |
| Selenium | 0.00077 | SA | SA | SA | < 0.0005 | (Pace 0.00022 J)< 0.0005 | SA | < 0.0005 | < 0.0005 | 0.05 | 0.05 |
| Silver | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.1 | 0.1 |
| Thallium | NR | SA | SA | SA | NR | NR | SA | NR | NR | 0.002 | 0.002 |
| Tin | NR | SA | SA | SA | NR | NR | SA | NR | NR | | |
| Vanadium | 0.0075 | SA | SA | SA | < 0.001 | 0.0019 | SA | < 0.001 | < 0.001 | - - - | - - - |
| Zinc | (Pace 0.0014 J)< 0.005 | SA | SA | SA | 35.4 | 0.38 | SA | 38.5 | (Pace 0.002 J)< 0.005 | 5 | 2 |
| **INORGANICS (mg/L)** | | | | | | | | | | | |
| Chloride | 57.6 | 20.1 | 42.6 | 77.9 | 29.3 | 38.6 | SA | 29.5 | 1.1 | 250 | - - - |
| Chemical Oxygen Demand | < 50 | < 50 | 73.6 | 625 | NR | NR | SA | NR | NR | - - - | - - - |
| Specific Conductance (umhos/cm) | 918 | 504 | 1720 | 3960 | 1550 | 1560 | SA | 1460 | 3.6 | - - - | - - - |
| Cyanide | (Pace 0.0048 J)< 0.01 | 0.0142 | (Pace 0.004 J)< 0.01 | 0.012 | NR | NR | SA | NR | NR | - - - | 0.2 |
| Nitrate\Nitrite - N | 4.4 | 0.24 | 0.95 | 0.22 | NR | NR | SA | NR | NR | 10 | 10 |
| pH | 6.5 | 6.6 | 6.4 | 4.9 | 5.9 | 6.3 | SA | 5.8 | 6.2 | | |
| Sulfate | 140 | 79 | 653 | 2860 | 615 | 600 | SA | 569 | < 2.5 | 250 | - - - |
| Sulfide | < 0.1 | < 0.1 | < 0.1 | < 0.1 | NR | NR | SA | NR | NR | | |
| **EPA METHOD 8260 (µg/L)** | | | | | | | | | | | |
| Acetone | < 20 | < 20 | < 20 | (Pace 11.6 J)< 20 | SA | SA | (Pace 10.1 J)< 20 | SA | < 20 | - - - | - - - |
| Benzene | < 1 | < 1 | < 1 | (Pace 0.49 J)< 1 | SA | SA | (Pace 0.54 J)< 1 | SA | < 1 | 5 | 5 |
| Carbon Disulfide | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | - - - | - - - |
| Chloroethane | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | - - - | - - - |
| Chloroform | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | - - - | 70 |
| Chloromethane | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | - - - | - - - |
| 1,4-Dichlorobenzene | < 1 | < 1 | < 1 | 1.8 | SA | SA | 1.9 | SA | < 1 | 75 | 75 |
| Dichlorodifluoromethane | < 1 | < 1 | < 1 | (Pace 0.84 J)< 1 | SA | SA | (Pace 0.86 J)< 1 | SA | < 1 | - - - | 1000 |
| 1,1-Dichloroethane | < 1 | < 1 | (Pace 0.27 J)< 1 | (Pace 0.98 J)< 1 | SA | SA | (Pace 0.99 J)< 1 | SA | < 1 | - - - | - - - |
| 1,2-Dichloroethane | < 1 | < 1 | (Pace 1 J)< 1 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 4 |
| cis-1,2-Dichloroethene | < 1 | < 1 | 3.4 | 2.6 | SA | SA | 2.7 | SA | < 1 | 70 | 70 |
| trans-1,2-Dichloroethene | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | 100 | 100 |
| Ethylbenzene | < 1 | < 1 | < 1 | < 1 | SA | SA | < 1 | SA | < 1 | | |
| 1,2-Dichloropropane | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | 5 | 5 |
| 4-Isopropyltoluene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | - - - |
| Methylene Chloride | < 4 | < 4 | < 4 | < 4 | SA | SA | < 4 | SA | < 4 | 5 | 30 |
| Naphthalene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | 100 |
| Tetrachloroethene | < 1 | < 1 | 1.1 | < 1 | SA | SA | < 1 | SA | < 1 | 5 | 5 |
| Trichloroethene | < 0.4 | < 0.4 | 0.66 | (Pace 0.21 J)< 0.4 | SA | SA | < 0.4 | SA | < 0.4 | 5 | 5 |
| 1,2,4-Trimethylbenzene | NR | NR | NR | NR | SA | SA | NR | SA | NR | - - - | - - - |
| Vinyl Chloride | < 0.2 | < 0.2 | < 0.2 | 1.1 | SA | SA | 1.1 | SA | < 0.2 | 2 | 0.2 |
| **EPA METHOD 8270 (µg/L)** | | | | | | | | | | | |
| bis(2-ethylhexyl)Phthalate | SA | SA | SA | SA | SA | SA | SA | SA | SA | 6 | 6 |
| **EPA METHOD 8151 (µg/L)** | | | | | | | | | | | |
| Picloram | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| Dicamba | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4,5-TP (Silvex) | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| 2,4-D | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8081 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |
| **EPA METHOD 8082 (µg/L)** | SA | SA | SA | SA | SA | SA | SA | SA | SA | | |

KEY:

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL)
SA = Sample Not Taken

mg/L = milligram per Liter
µg/L = microgram per Liter
EPA = U.S. Environmental Protection Agency
MCL = Maximum Contaminant Levels
HHS = Montana Human Health Standards

### BUTTE-SILVER BOW CLOSED LANDFILL AND CLARK TAILINGS
### TABLE 3: GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
### DATE SAMPLED: March 13 and 14, 2018

| Well ID | Sample # | Depth (ft) | Diameter (ft) | SWL (ft) | TOC Elevation (ft) | Groundwater Elevation (ft) | pH (su) | ORP (mV) | DO (mg/L) | SC (µS/cm) | T (Celsius) | Sample Time | $H_2O$ Volume Required (gal) | $H_2O$ Volume Purged (gal) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MBMG-2 | BSB-GW-01 | 23.25 | 0.17 | 11.15 | 5529.88 | 5518.73 | 7.24 | -312.7 | 6.47 | 851 | 6.8 | 10:25 | 6.00 | 8.50 | |
| BSB-A1 | BSB-GW-02 | 57.00 | 0.17 | 33.76 | 5531.50 | 5497.74 | 7.11 | -334.0 | 1.66 | 482 | 9.8 | 11:40 | 12.00 | 13.25 | |
| BSB-A5 | BSB-GW-03 | 46.50 | 0.17 | 40.23 | 5524.62 | 5484.39 | 6.72 | 169.7 | 5.76 | 1736 | 9.2 | 12:22 | 3.14 | 3.25 | |
| BSB-A6-R | BSB-GW-04 | 59.75 | 0.17 | 50.61 | 5554.41 | 5503.80 | 6.00 | -161.9 | 1.0 | 4.23 | 10.7 | 14:05 | 4.57 | 6.25 | |
| BSB-A6-R | BSB-GW-07 | 59.75 | 0.17 | 50.61 | 5554.41 | 5503.80 | 6.00 | -161.9 | 1.0 | 4.23 | 10.7 | 14:07 | 4.57 | 6.25 | VOC Duplicate |
| CLK-1 | BSB-GW-05 | 19.00 | 0.17 | 5.01 | 5478.73 | 5473.72 | 6.45 | -378.3 | 3.08 | 1530 | 8.3 | 11:00 | 7.00 | 8.00 | |
| CLK-2 | BSB-GW-06 | 46.90 | 0.17 | 40.47 | 5511.17 | 5470.70 | 6.47 | -222.6 | 11.92 | 1570 | 9.2 | 9:52 | 3.22 | 4.75 | |
| CLK-1 | BSB-GW-08 | 19.00 | 0.17 | 5.01 | 5478.73 | 5473.72 | 6.45 | -378.3 | 3.08 | 1530 | 8.3 | 11:02 | 7.00 | 8.00 | Raw and Dissolved Metals Duplicate |
| Blank | BSB-GW-09 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 12:00 | NA | NA | Field Blank |

**KEY:**

| | | | |
|---|---|---|---|
| ft | feet | SC | Specific Conductance |
| SWL | static water level | µS/cm | micro-Siemens per centimeter |
| TOC | top of casing | T | temperature |
| pH | Potential of Hydrogen | $H_2O$ | water |
| su | standard unit | gal | gallons |
| ORP | Oxidation Reduction Potential | NA | measurement not taken |
| mV | millivolts | | |
| DO | Dissolved Oxygen | | |
| mg/L | milligrams per Liter | | |

3/13/18

GW Sampling of OLD LANDFILL

Calibration of field parameter meters (white blue meters)

pH: 4.01 → 4.00, 3.87
7.00 → 7.00, 7.01 SLP → 92.2
10.01 → 10.01, 10.02
Cond.: 1413 uS/cm → std 1413 uS/cm
0.458, 18.4°C
DO: 102.3 % sat, 24°C
6.91 mg/L 18°C
ORP: 424.0 RmV @ 19.0°C
-44.5 Off Set
378.8 mV, 423.3 RmV

Today's activities: sample wells at the Old Landfill

On-site personnel: Patty Navarro, Brian Kremer and Brad Holkamon (Pioneer)

Weather: Sunny, 12 °F

Safety: Slip hazards due to deep snow. Plan your path and walk cautiously. Use sled to transport equipment to wells that cannot be accessed with vehicle due to deep snow.

PPE: Hard hat, high-vis. outwear, safety glasses, nitrile & work gloves.

09:20 → arrived at site.

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3/13/18

09:33 → arrived @ MBMG-2
DTW: 11.15', TD: 23.25'
09:48: begin purging with 12-volt 3 stage pump at 0.5 L/min. T. Stanich (Pioneer) joined the team
10:25 → stopped purging, 8.5 gal total

Field parameters were recorded on field data sheet

Collected BSB-GW-01 at 10:25
1 - 250ml / Filtered / $HNO_3$ / Dissolved Metal
1 - 250ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD
1 - 250ml / NaOH / Cyanide
1 - 250ml / NaOH & Zinc Acetate / Sulfide
3 - 40ml / HCL / VOCs 8260b
1 - 1 L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

10:50 → arrived at BSB - A1
DTW: 33.76', TD: 57
11:00 → begin purging with 12-volt 3 stage pump at 1L/min
11:31 → begin to collect field parameters. Field parameters were recorded on field data sheet
11:40 → stopped purging, 13.25 gal

Collected BSB-GW-02 at 11:40
1 - 250ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD
1 - 250ml / NaOH / Cyanide
1 - 250ml / NaOH & Zinc Acetate / Sulfide

Rite in the Rain

3/13/18

BSB-GW-02 sample (cont.)

3-40ml / HCL / VOCs 8260b

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

11:50 → decontaminated pump

12:03 → arrived at BSB-AS

DTW: 40.23', TD: 46.50'

12:05 → begin purging with bailer

12:16 → Stopped purging with bailer and started to collect field parameters.

Field parameters were recorded on field data sheet.

ORP values from well BSB-A1 were negatives. team decided to calibrate ORP meter again

ORP: 430.0 RmV @ 12 °C

-80.4 Off set

355.1 mV, 435.8 RmV

12:22 → collected BSB-GW-03

1-250 ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD

1-250ml / NaOH / Cyanide

1-250ml / NaOH & Zinc Acetate / sulfide

3-40ml / HCL / VOCs 8260b

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

13:00 → arrived at BSB-A6-R

DTW: 50.61', DT: 59.75'

3/13/18

13:10 → begin purging with 12-volt, 3 stage pump at 0.75 L/min

13:20 → changed rate to 0.5 L/min

13:52 → begin to collect field parameters. Field Parameters were recorded on field data sheet.

14:05 → stopped purging, 6.25 gal total

Collected BSB-GW-04 at 14:05

1-250ml / $H_2SO_4$ / $NO_2$-$NO_3$, COD

1-250ml / NaOH / Cyanide

1-250ml / NaOH & Zinc Acetate / Sulfide

3-40ml / HCL / VOCs 8260b

1-1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

Collected BSB-GW-07 at 14:07

(sample BSB-GW-07 is the duplicate sample of well BSB-A6-R)

3-40ml / HCL / VOCs 8260b

14:15 → decontaminated pump

14:25 → P. Navarro, B. Kremer, T. Stanich offsite.

Patricia Navarro B 3/13/18

Rite in the Rain

3/14/18

GW Sampling of OLD LANDFILL

Calibration of field parameter meters
(white-blue meters)

pH: 4.01 → 4.00
7.00 → 7.00 SLP → 94.9
10.01 → 10.01

Cond: 1413 μS/cm
0.458, 17.9°C

DO: 102.3 % sat, 16 °C
8.11 mg/L, 15.7°C

ORP: 424.0 @ 19.6 °C
-46.9 Off Set
376.9mV/424.0 RmV
376.1mV / 423.0 RmV

Today's activities: sample wells at the OLD Landfill

On-Site Personnel: Patty Navarro and Brian Kremer } Pioneer

Weather: Partly cloudy, 29°F

Safety: well CLK-2 is located by a road. Personnel will watch for moving vehicles, use hazard lights on vehicles.

PPE: Hard hat, high-vis outwear, safety glasses, nitrile & work gloves.

3/14/18

09:20 → arrived at CLK-2
DTW: 40.47', TD: 46.90'
09:30 → begin purging with 12-volt, 3 stage pump at a rate of 35 sec/0.5 L.
09:43 → begin to collect field parameters. Field parameters were recorded on field data sheet.
09:52 → stopped purging, 4.75 gal. total
Collected BSB-GW-06 at 09:52
1 - 250ml / Filtered / $HNO_3$ / Dissolved metals
1 - 1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$
09:57 → decontaminated pump

10:10 → arrived at CLK-1
DTW: 5.01, TD: 19.00
10:18 → begin purging with 12-Volt, 3 stage pump at a rate of 1L/min
10:50 → begin to collect field parameters. Field parameters were recorded on field data sheet.
11:00 → stopped purging, 8 gal. total

Collected BSB-GW-05 at 11:00
1 - 250 ml / Filtered / $HNO_3$ / Dissolved metals
1 - 1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

Rite in the Rain

3/14/18

Collected BSB-GW-08 at 11:02
(Sample BSB-GW-08 is the duplicate sample of well CLK-1)

1 - 250 ml / Filtered / $HNO_3$ / Dissolved metals
1 - 1 L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

11:05 → decontaminated pump
11:20 → P. Navarro and B. Kremer off site
12:26 → Collected BSB-GW-09 by pouring DI water into bottles (Field Blanks)

1 - 250ml / $HNO_3$ / Dissolved metals
3 - 40ml / HCL / VOCs 8260b
1 - 1L / Raw / pH, SC, $Cl^-$, $SO_4^{-2}$

14:14 → P. Navarro dropped off coolers (2) at FedEx. Tracking #s: 747598310948; 747596380210.

3/15/18 → Coolers (2) were delivered to Pace Analytical at 09:51.

3/16/18 → P. Navarro emailed Bob Michels (Pace Analytical) to have all samples requiring dissolved metals (BSB-GW-05, BSB-GW-06, BSB-GW-08, BSB-GW-09, and BSB-GW-01) be analyzed for mercury also (Method EPA 245.1). This is required every 2 years.

Rite in the Rain

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB Old Landfill
WELL/STATION: MBMG-2 DATE: 3/13/18 TIME: 09:33
SAMPLERS: PN/BK/TS WEATHER CONDITIONS: Sunny, 12°F
PHOTO: YES ____ NO X NUMBER: N/A

---

### PURGE DATA:

WELL DEPTH: 23.25 FEET
PURGE METHOD: 12-volt, 3 stage pump DEPTH TO WATER: 11.15 FEET
START PURGING: 09:48 COLUMN DEPTH: 12.10 FEET
PURGE RATE: 0.5 L/min ~~GPM~~ CASING DIAMETER: 2 INCH
RATE CHANGE: 1) TIME: ____ RATE: ____ PUMP SET AT: 19 FEET
2) TIME: ____ RATE: ____ 3 WELL VOLUMES: 6 GALLONS
SAMPLE TIME: 10:25 TOTAL PURGE VOLUME: 8.5 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-01 | 250ml | ✓ | $HNO_3$ | Dissolved Metals |
| | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| | 250ml | | NaOH | Cyanide |
| | 250ml | | NaOH & Zin Acetate | Sulfide |
| | 3-40ml | | HCL | VOCs 8260 b |
| | 1-1L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 10:15 | 24L | 6.4 | 7.28 | 838 | -312.6 | 8.14 |
| 10:17 | 26L | 6.8 | 7.26 | 841 | -312.8 | 7.18 |
| 10:19 | 28L | 6.9 | 7.25 | 846 | -312.9 | 7.03 |
| 10:21 | 30L | 6.9 | 7.25 | 845 | -314.4 | 6.65 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 10:23 | 32L | 6.8 | 7.24 | 851 | -312.7 | 6.47 |

FIELD REMARKS: ____

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB Old Landfill

WELL/STATION: BSB - A1 DATE: 3/13/18 TIME: 10:50

SAMPLERS: PN/BK/TS WEATHER CONDITIONS: Sunny, 21 °F

PHOTO: YES ______ NO X NUMBER: N/A

---

### PURGE DATA:

PURGE METHOD: 12-volt, 3 stage pump

START PURGING: 11:00

PURGE RATE: 1 L/min GPM

RATE CHANGE: 1) TIME: ______ RATE: ______

2) TIME: ______ RATE: ______

SAMPLE TIME: 11:40

WELL DEPTH: 57 FEET

DEPTH TO WATER: 33.76 FEET

COLUMN DEPTH: 23.24 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 55 FEET

3 WELL VOLUMES: 12 GALLONS

TOTAL PURGE VOLUME: 13.25 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-02 | 250ml | | $H_2SO_4$ | $NO_2$ - $NO_3$, COD |
| ↓ | 250ml | | NaOH | Cyanide |
| | 250ml | | NaOH & Zinc Acetate | Sulfide |
| | 3-40ml | | HCL | VOCs 8260b |
| | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 11:31 | 11.75gal | 9.7 | 7.12 | 474 | -342.4 | 1.56 |
| 11:33 | 12.25gal | 9.6 | 7.12 | 476 | -335.1 | 1.56 |
| 11:35 | 12.75gal | 9.7 | 7.12 | 479 | -338.5 | 1.58 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 11:37 | 13.25 | 9.8 | 7.11 | 482 | -334.0 | 1.66 |

FIELD REMARKS: Water was turbid.

**PIONEER TECHNICAL SERVICES, INC.**

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB Old Landfill
WELL/STATION: BSB-A5 DATE: 3/13/18 TIME: 12:03
SAMPLERS: PN/BK/TS WEATHER CONDITIONS: Sunny, 33°F
PHOTO: YES ____ NO X NUMBER: N/A

---

## PURGE DATA:

PURGE METHOD: Bailer
START PURGING: 12:05
PURGE RATE: ____ GPM
RATE CHANGE: 1) TIME: ____ RATE: ____
2) TIME: ____ RATE: ____
SAMPLE TIME: 12:22

WELL DEPTH: 46.50 FEET
DEPTH TO WATER: 40.23 FEET
COLUMN DEPTH: 6.27 FEET
CASING DIAMETER: 2 INCH
PUMP SET AT: — FEET
3 WELL VOLUMES: 3.14 GALLONS
TOTAL PURGE VOLUME: 3.25 GALLONS

---

## SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-03 | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| ↓ | 250ml | | NaOH | Cyanide |
| ↓ | 250ml | | NaOH & Zinc Acetate | Sulfide |
| ↓ | 3-40ml | | HCL | VOCs 8260b |
| ↓ | 1L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

## FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
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| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 12:21 | 3.25gal | 9.2 | 6.72 | 1736 | 169.7 | 5.76 |

FIELD REMARKS: Water was dark brown.

PIONEER TECHNICAL SERVICES, INC.

## FIELD SAMPLE DATA SHEET

Page 1 of 1

PROJECT NAME: BSB Old Landfill

WELL/STATION: BSB-AGR DATE: 3/13/18 TIME: 13:00

SAMPLERS: PN/BK/TS WEATHER CONDITIONS: Sunny, 43°F

PHOTO: YES ____ NO X NUMBER: N/A

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### PURGE DATA:

WELL DEPTH: 59.75 FEET

PURGE METHOD: 12-volt, 3 stage pump

DEPTH TO WATER: 50.61 FEET

START PURGING: 13:10

COLUMN DEPTH: 9.14 FEET

PURGE RATE: 0.75 L/min ~~GPM~~

CASING DIAMETER: 2 INCH

RATE CHANGE: 1) TIME: 13:20 RATE: 0.5 L/min

PUMP SET AT: 58 FEET

2) TIME: ____ RATE: ____

3 WELL VOLUMES: 4.57 GALLONS

SAMPLE TIME: 14:05, 14:07 (Dup.)

TOTAL PURGE VOLUME: 6.25 GALLONS

---

### SAMPLE DATA:

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-04 | 250ml | | $H_2SO_4$ | $NO_2$-$NO_3$, COD |
| ↓ | 250ml | | NaOH | Cyanide |
| ↓ | 250ml | | NaOH & Zinc Acetate | Sulfide |
| ↓ | 3-40ml | | HCL | VOCs 8260b |
| ↓ | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |

### FIELD PARAMETERS:

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 13:52 | 5 gal | 11.0 | 5.97 | 4.20 | -207.1 | 1.27 |
| 13:54 | 5.25 gal | 10.8 | 5.98 | 4.21 | -200.3 | 1.31 |
| 13:56 | 5.50 gal | 10.8 | 5.98 | 4.20 | -184.9 | 1.26 |
| 13:58 | 5.75 gal | 10.8 | 5.99 | 4.20 | -171.0 | 1.14 |
| 14:00 | 6 gal | 10.8 | 6.00 | 4.22 | -165.9 | 1.02 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 14.02 | 6.25 gal | 10.7 | 6.00 | 4.23 | -161.9 | 1.00 |

**FIELD REMARKS:** Water was dark green with gas odor. Sample BSB-GW-07 was collected at 14:07 (duplicate for well BSB-A6-R, 3-40ml vials for VOCs).

**PIONEER TECHNICAL SERVICES, INC.**

**FIELD SAMPLE DATA SHEET** Page 1 of 1

PROJECT NAME: BSB Old Landfill/Clark Tailings

WELL/STATION: CLK-2 DATE: 3/14/18 TIME: 09:20

SAMPLERS: PN/BK WEATHER CONDITIONS: Partly Cloudy, 29°F

PHOTO: YES ____ NO X NUMBER: N/A

---

**PURGE DATA:**

WELL DEPTH: 46.90 FEET

PURGE METHOD: 12-volt, 3 stage pump

DEPTH TO WATER: 40.47 FEET

START PURGING: 09:30

COLUMN DEPTH: 6.43 FEET

PURGE RATE: 0.5 L/35 sec ~~GPM~~

CASING DIAMETER: 2 INCH

RATE CHANGE: 1) TIME: ____ RATE: ____

PUMP SET AT: 45 FEET

2) TIME: ____ RATE: ____

3 WELL VOLUMES: 3.22 GALLONS

SAMPLE TIME: 09:52

TOTAL PURGE VOLUME: 4.75 GALLONS

---

**SAMPLE DATA:**

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-06 | 250ml | ✓ | HNO3 | Dissolved metals |
| BSB-GW-06 | 1 L | | Raw | pH, SC, Cl⁻, SO4⁻² |
| | | | | |
| | | | | |
| | | | | |

**FIELD PARAMETERS:**

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 09:43 | 12 L | 9.2 | 6.5 | 1572 | -226.5 | 13.56 |
| 09:45 | 14 L | 9.2 | 6.48 | 1570 | -225.8 | 12.59 |
| 09:47 | 16 L | 9.1 | 6.47 | 1573 | -224.5 | 12.25 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| FINAL FIELD PARAMETERS PRIOR TO SAMPLING | | | | | | |
| 09:49 | 18L | 9.2 | 6.47 | 1570 | -222.6 | 11.92 |

FIELD REMARKS: ____

**PIONEER TECHNICAL SERVICES, INC.**

**FIELD SAMPLE DATA SHEET**

Page 1 of 1

PROJECT NAME: BSB Old Landfill / Clark Tailings

WELL/STATION: CLK-1 DATE: 3/14/18 TIME: 10:10

SAMPLERS: PN/BK WEATHER CONDITIONS: Partly Cloudy, 29 °F

PHOTO: YES ____ NO X NUMBER: N/A

---

**PURGE DATA:**

PURGE METHOD: 12-volt, 3 stage pump

START PURGING: 10:18

PURGE RATE: 1 L/min ~~GPM~~

RATE CHANGE: 1) TIME: ____ RATE: ____

2) TIME: ____ RATE: ____

SAMPLE TIME: 11:00, 11:02 (Dup.)

WELL DEPTH: 19.00 FEET

DEPTH TO WATER: 5.01 FEET

COLUMN DEPTH: 13.99 FEET

CASING DIAMETER: 2 INCH

PUMP SET AT: 15 FEET

3 WELL VOLUMES: 7 GALLONS

TOTAL PURGE VOLUME: 8 GALLONS

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**SAMPLE DATA:**

| SAMPLE # | VOLUME | CHECK IF FILTERED | PRES. | ANALYSIS REQUESTED |
|---|---|---|---|---|
| BSB-GW-05 | 250 ml | ✓ | $HNO_3$ | Dissolved metals |
| BSB-GW-05 | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| BSB-GW-08 | 250 ml | ✓ | $HNO_3$ | Dissolved metals |
| BSB-GW-08 | 1 L | | Raw | pH, SC, $Cl^-$, $SO_4^{-2}$ |
| | | | | |

**FIELD PARAMETERS:**

| TIME | AMOUNT PURGED | TEMP (°C) | pH | SC (µS/cm) | ORP (mV) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 10:50 | 6 gal. | 8.2 | 6.47 | 1524 | -376.2 | 5.24 |
| 10:52 | 6.5 gal. | 8.3 | 6.46 | 1523 | -376.3 | 4.33 |
| 10:54 | 7 gal. | 8.3 | 6.45 | 1527 | -377.1 | 3.78 |
| 10:56 | 7.5 gal. | 8.4 | 6.45 | 1529 | -378.6 | 3.36 |
| | | | | | | |
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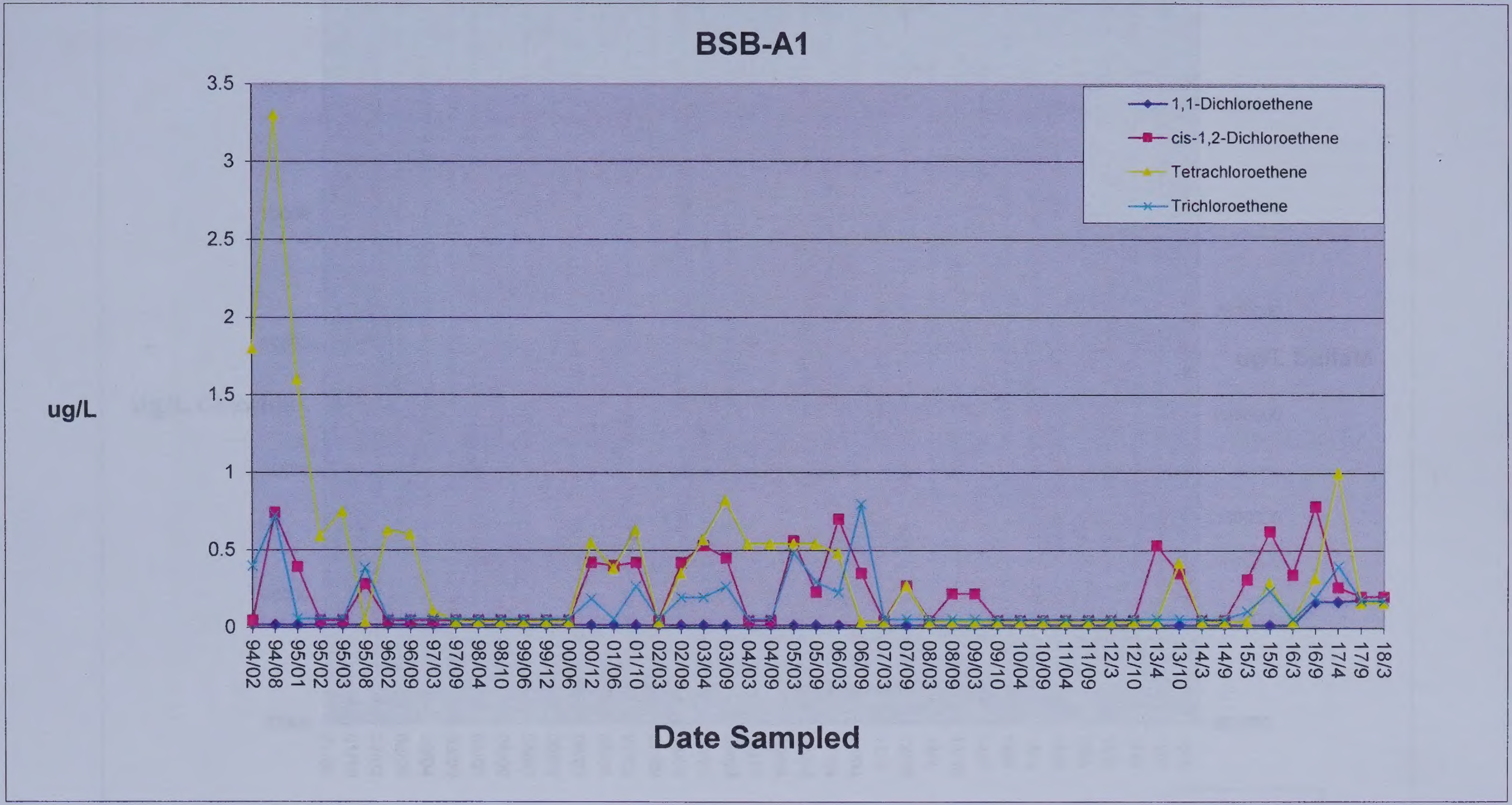
| | | | | | | |
| **FINAL FIELD PARAMETERS PRIOR TO SAMPLING** | | | | | | |
| 10:58 | 8 gal. | 8.3 | 6.45 | 1530 | -378.3 | 3.08 |

FIELD REMARKS: Water was turbid. Sample BSB-GW-08 was collected at 11:02 (duplicate for well CLK-1).

**PIONEER TECHNICAL SERVICES, INC.**


BSB-A1
ug/L
3.5
3
2.5
2
1.5
1
0.5
0
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/03
02/09
03/04
03/09
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07/03
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09/03
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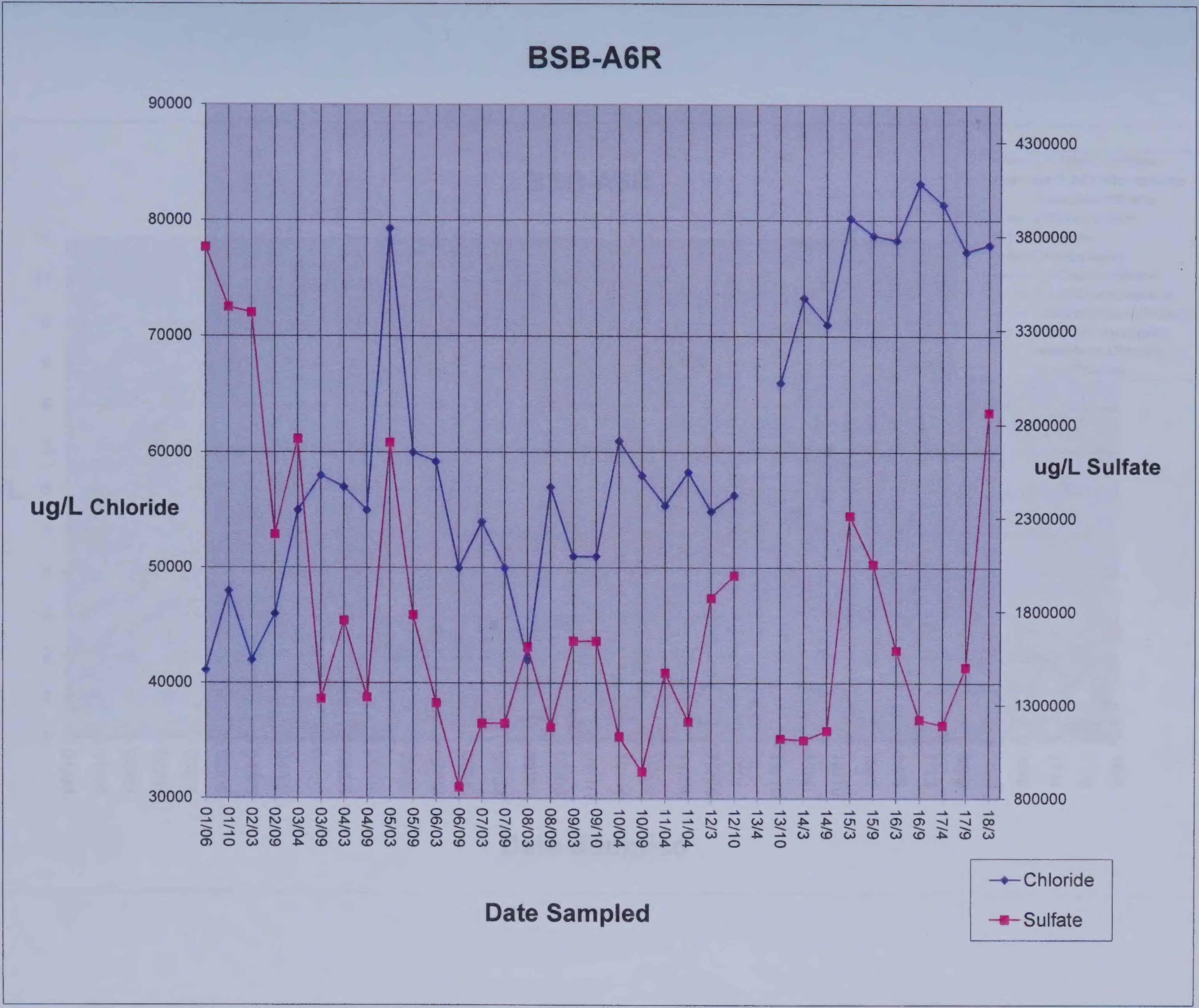
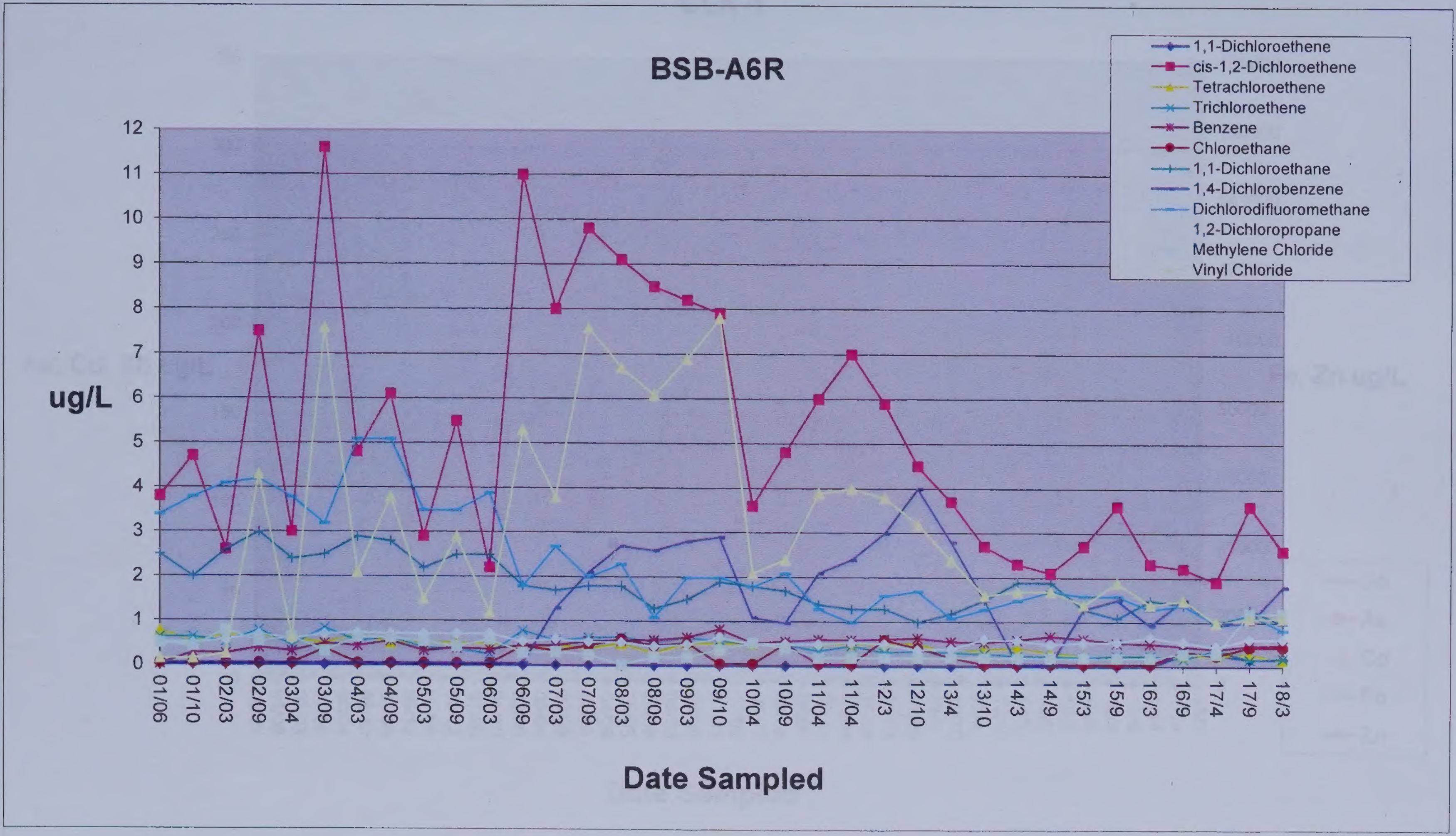
10/04
10/09
11/04
11/09
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
18/3
Date Sampled


BSB-A6R
90000
80000
70000
60000
50000
40000
30000
ug/L Chloride
4300000
3800000
3300000
2800000
2300000
1800000
1300000
800000
ug/L Sulfate
01/06
01/10
02/03
02/09
03/04
03/09
04/03
04/09
05/03
05/09
06/03
06/09
07/03
07/09
08/03
08/09
09/03
09/10
10/04
10/09
11/04
11/04
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
18/3
Date Sampled
Chloride
Sulfate


BSB-A6R
ug/L
12
11
10
9
8
7
6
5
4
3
2
1
0
01/06
01/10
02/03
02/09
03/04
03/09
04/03
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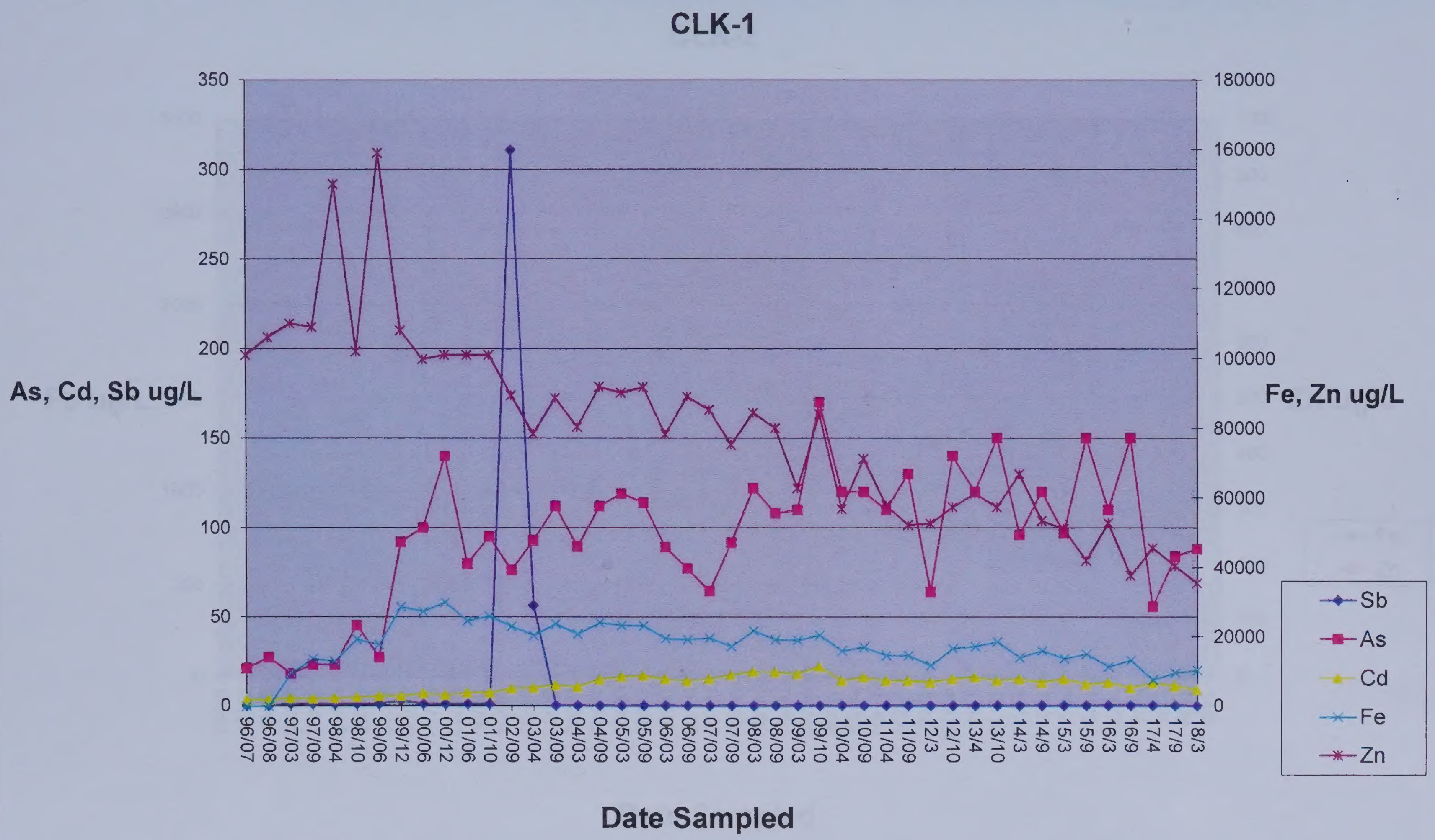
08/09
09/03
09/10
10/04
10/09
11/04
11/04
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
18/3
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride


CLK-1
As, Cd, Sb ug/L
350
300
250
200
150
100
50
0
Fe, Zn ug/L
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/09
03/04
03/09
04/03
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10/04
10/09
11/04
11/09
12/3
12/10
13/4
13/10
14/3
14/9
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16/3
16/9
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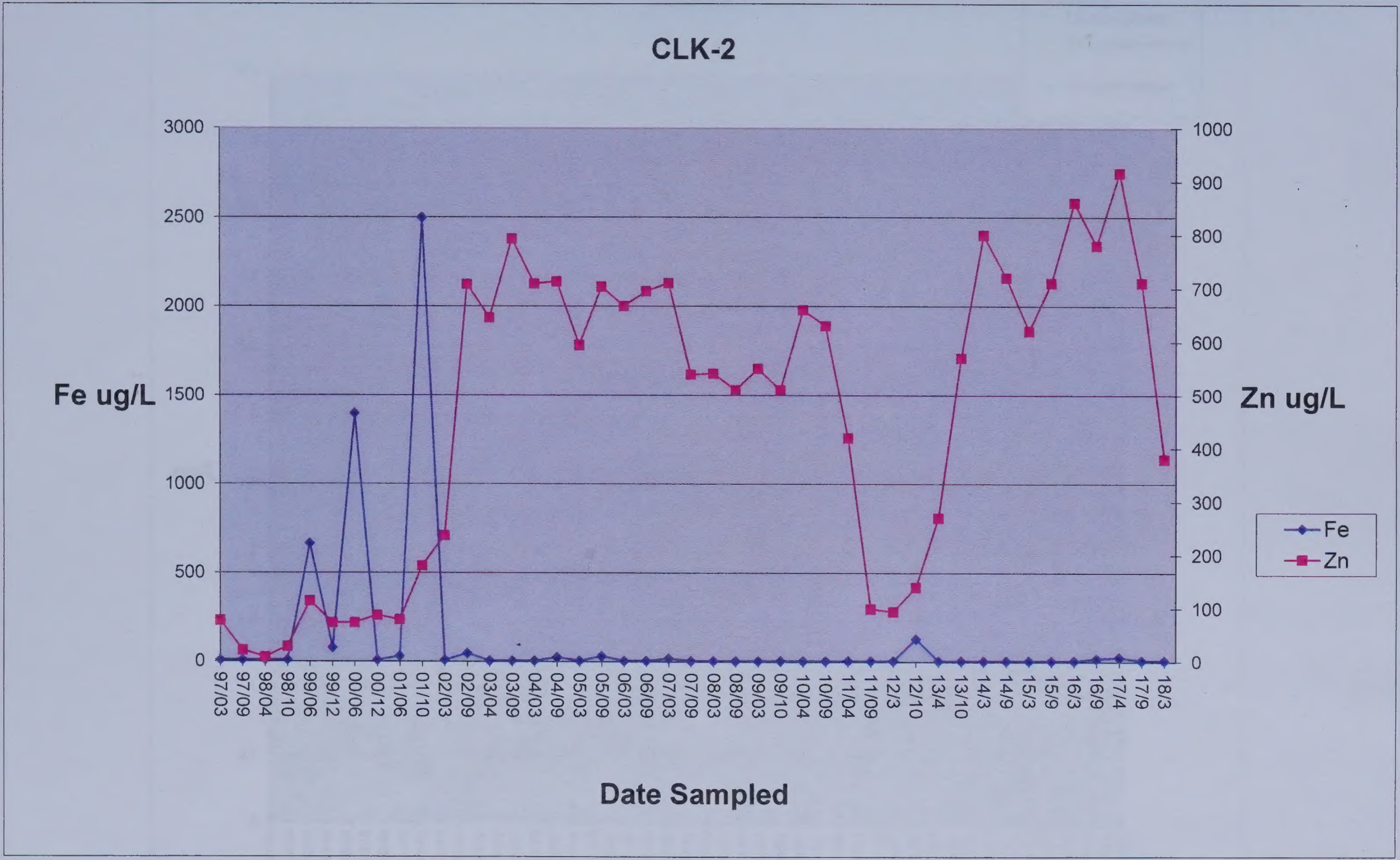
17/9
18/3
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
Fe ug/L
3000
2500
2000
1500
1000
500
0
Zn ug/L
1000
900
800
700
600
500
400
300
200
100
0
Fe
Zn
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/03
02/09
03/04
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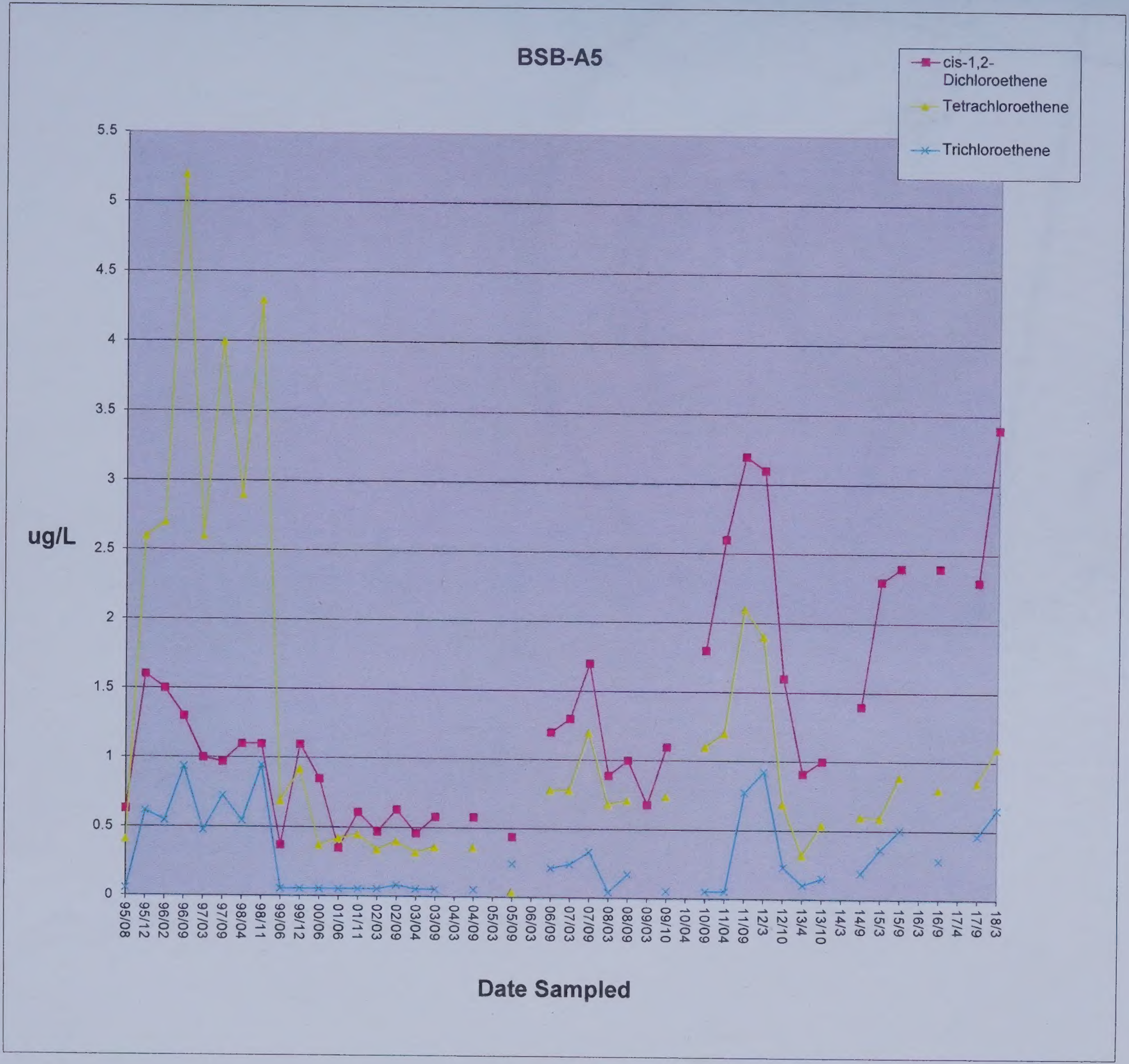
16/9
17/4
17/9
18/3
Date Sampled

BSB-A5
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
ug/L
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
95/08
95/12
96/02
96/09
97/03
97/09
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98/11
99/06
99/12
00/06
01/06
01/11
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Date Sampled